2012/3-4

REVIEW OF FACULTY OF ENGINEERING

Analecta Technica Szegedinensia

UNIVERSITY OF SZEGED
UNIVERSITAS SCIENTIARUM SZEGEDIENSIS
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SZEGED
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NUMBER OF COPIES (100 PIECES) PRINTED:
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Kereskedelmi Kft.
6724 Szeged, Textilgyári út 2.
Telefon/fax: + 36 62 458 717
e-mail: goldprint@vnet.hu, honlap: www.goldprint.hu

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H-6724 Szeged, Mars tér 7.
Phone: +36 (62) 546 000
ISSN 1788-6392

CONTENTS

50TH ANNIVERSARY OF ENGINEERING EDUCATION IN SZEGED

DEAN'S WELCOME

Half a century, was born in the domestic food higher education. Fifty years of engineering education in Szeged. For five decades, the main base of economic and rural development in Szeged, Mars square 7 building. Anyway, we emphasize how the figure for the half century anniversary illustrious institution. 50 remembering the anniversary of an incentive, an opportunity to summarize and foresight required to report.

Szeged, our institute connects the Hungarian food industry professionals, most of the leaders. In the 70s, suddenly leaping legs industry, the South Plains region features wanted us to two of our students graduate in three engineering technologist, and as a mechanical engineer graduated from our institute. In the 90 years from slowing down the development of industry, and has appeared in the third type: the engineering manager, that is, the economic demand for engineers. The traditional food engineering and agricultural and mechanical engineering, and economic and rural development in agricultural engineering training courses along with special preference also appeared: the IT and technical management in agricultural engineering. The environmental and engineering of the material, or even a technical trainer, or training in mechatronics engineers and other faculties of the Szeged universitas we participate together. Meanwhile, we reversed the typical educational institution structure, the former agriculture and food rather than technical nature, and placed the emphasis on training engineers. The high-quality and practice-oriented Master's degree courses, but also an opportunity opened. The postgraduate courses in higher education while also expanding the range. Because the "What is a good engineer?" Question, we know the answer and continue to renew. In a science-established, mainly in industrial technology and design professionals interested in the operation of image we who have serious economic, technical and IT knowledge, is knowledge of foreign languages as well.

While the typical course, based on mutual respect and student teacher relationship in the future connecting the Alma Mater engineers as well. Thus we contribute to the Szeged universitas of the mission, which is 75 years, the Nobel Prize winning Albert Szent-Gyorgyi Rector's inaugural address said that "our universities to our (...) special vocation: to the great Hungarian Great Plain intellectual center must be".

Prof. Dr. Antal Veha
dean
University of Szeged
Faculty of Engineering

RETENTION AND LIPOPHILICITY OF NEWLY SYNTHESIZED 3-BENZYLOXY STEROID DERIVATIVES IN NORMAL- AND REVERSED-PHASE HPLC

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[2]FINS, Bulevar Cara Lazara 1, 21000 Novi Sad, Serbia

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ABSTRACT

The retention behaviour and separation ability of nine newly synthesized 3-benzyloxy estrone derivatives were studied by HPLC on silica and C-18 commercially available columns. The mobile phases used were: benzene-ethyl acetate, benzene-tetrahydrofuran, benzene-acetonitrile, methanol-water and acetonitrile-water in various proportions. The results are discussed in terms of nature of the solute, eluent and stationary phase.

The correlation between the retention constants of nine 3-benzyloxy estrone derivatives obtained on C-18 column and calculated log *P* was examined too.

1. INTRODUCTION

Steroids are of great interest owing to their varied biological activity. The type of biological activity can changed by introduction and/or changing hydrophilic and hydrophobic functional groups, as well as by transforming the skeleton of the steroid molecule. Steroids are of interest in chromatographic investigations as they offer the opportunity to study the effect of substituents on retention [1-3].

As a continuation of our work on steroid molecule nine new estrogen derivatives have been synthesized in order to functionalize ring A and D of the skeleton, and hence attempt to change the hormonal activity of estrone. Estrogen hormones are female hormones and they promote primary, as well as secondary female characteristics. They play important role in the function of brain, bones, liver, and cardiovascular system [4, 5].

On the other hand development of steroidal compounds is often followed by research on structure-activity relationship studies. For initial chemical screening of activity of newly synthesized compounds, it is first recommended to determine their lipophilicity. Lipophilicity is quantitatively characterized as log *P* (the logarithm of the ratio of the concentrations of any analyte in a saturated 1-octanol-water system) [6-9]. Many methods for estimating log *P*, experimental as well as computational, are described in the literature [10]. The traditional experimental method for the detrmination of log $P_{o/w}$ is *shake flask* method [11]. Nowadays liquid chromatography has a tendency to replace tedious and poor interlaboratory reproducible *shake flask* method for measuring partition coefficients. Among liquid chromatography methods reversed-phase liquid chromatography (RPLC) is an alternative technique that can correlate the hydrophobicity of compounds with the retention parameters [12-14].

In addition to the experimental method, a number of other methods for calculation of 1-octanol-water partition coefficients have been estabilished.

Because of our interest in the biological activity of functionalized newly synthesized steroids and their future derivatives, our study had two objectives:

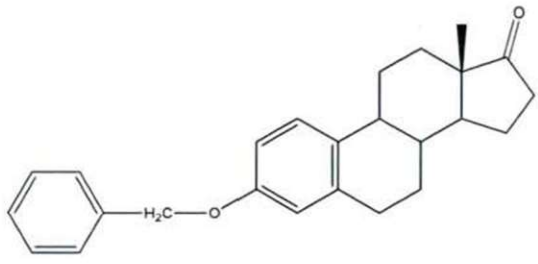
1.reports of the separation performance of normal (silica gel column) and reversed phase (C-18 column) HPLC of newly synthesized steroid compounds, and compares their retention behaviour, and

2. investigation correlation of chromatographically obtained constants in RPHPLC with calculated log *P* values [15].

The structures of the compounds investigated are presented in Table 1.

Table 1. The chemical structure of the compounds studied

1.



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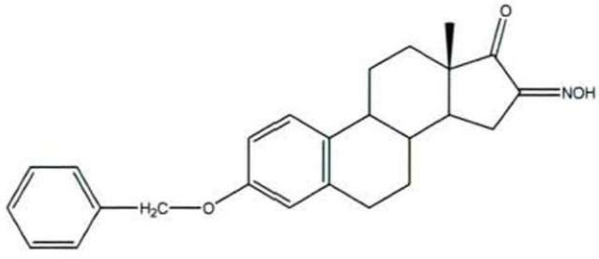

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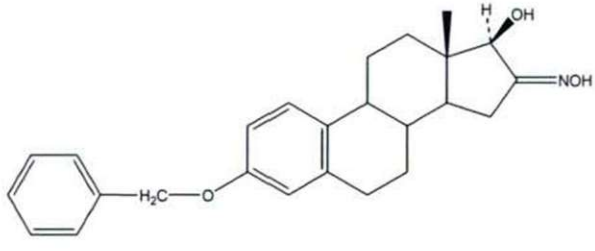

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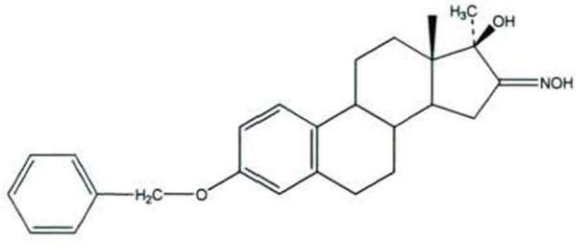

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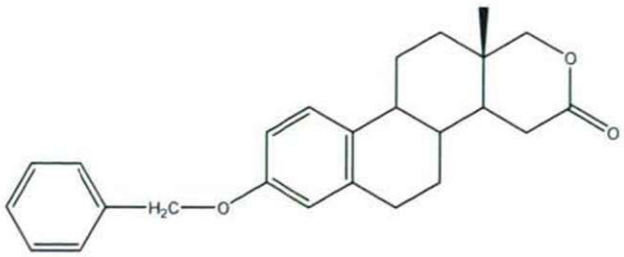
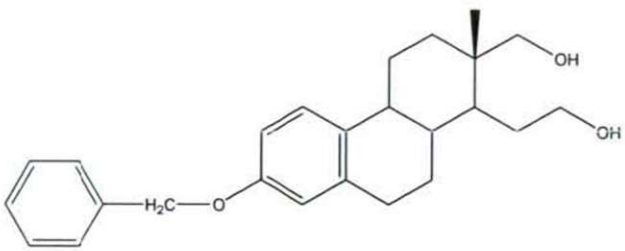

O
O
H2C
O

6.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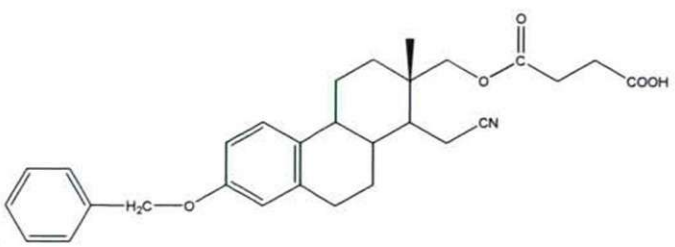
OH
H2C
O

7.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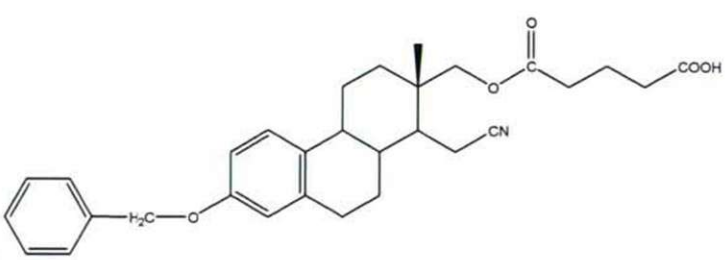
CN
H2C
O

8.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H2C
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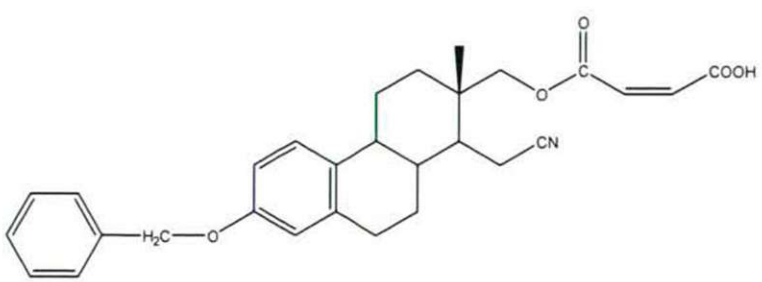
9.


O
O
C
COOH
CN
H2C
O

IUPAC names of steroids:
1. 3-Benzyloxyestra-1,3,5(10)-trien-17-one
2. 3-Benzyloxyestra -1,3,5(10)-triene-16,17-dione 16-oxime
3. 3-Benzyloxy-17β-hydroxyestra-1,3,5(10)-trien-16-one oxime
4. 3-Benzyloxy-17α-methyl-17β-hydroxyestra-1,3,5(10)-trien-16-one oxime
5. 3-Benzyloxy-17-oxa-D-homo-estra-1,3,5(10)-triene-16-on
6. 3-Benzyloxy-16,17-secoestra-1,3,5(10)-triene-16,17-diol
7. 3-Benzyloxy-17-succinoyloxy-16,17-secoestra-1,3,5(10)-triene-16-nitrile
8. 3-Benzyloxy-17-glutaroyloxy-16,17-secoestra-1,3,5(10)-triene-16-nitrile
9. 3-Benzyloxy-17-maleyloxy-16,17-secoestra-1,3,5(10)-triene-16-nitrile

2. EXPERIMENTAL

HPLC separations were performed on an Agilent 1100 Series HPLC (USA) including a degasser G1379 A, binary G1312 pump, ALS G1313A, COLCOM G1316A and DAD G1315B. The columns used were commercially available particle size 5 μm: Spherisorb SI 250 × 4 mm i.d. (E. Merck, Darmstadt, Germany) and Spherisorb ODS-2.5μm, 124 × 4 mm (Hewlett Packard, USA).

Steroid derivatives (Table 1), synthesized by original reactions or according to the literature methods [4, 5], were dissolved (0.05 mg mL^{-1}) in methanol, and the solutions filtered through a 0.2 μm Chromafil filter (Macherey-Nagel, Duren, Germany).

Three binary solvent systems were used as a mobile phase on silica gel column:

(**A**) benzene – ethyl acetate (0.02-0.25, increment, 2 and 5%)

(**B**) benzene – tetrahydrofuran (0.02-0.25, increment 2 and 5%)

(**C**) benzene – acetonitrile (0.02-0.25, increment 2 and 5%)

Two binary solvent systems were used as a mobile phase on octadecyl silica gel column:

(**D**) methanol – water (0.80-0.95, increment 5%)

(**E**) acetonitrile – water (0.70-0.90, increment 5%)

The eluents used to prepare mobile phases were of analytical grade. The flow rate was 1mL min^{-1} at room temperature.

The retention factor, k, was calculated from $k = \frac{t_r - t_0}{t_0}$, where t_r is the retention time of the solute and t_0 the column void time of methanol. Each t_r value was measured in triplicate and averaged.

The correlation analysis was performed by the use of the computer program Origin 6.1.

3. RESULTS AND DISCUSSION

All 3-benzyloxy estrone derivatives were examined by normal- and reversed-phase HPLC on silica gel and C-18 bonded silica gel columns. Detailed discussion of all experiments performed is not necessary and shall concentrate on the most important observations.

3.1. Normal- phase chromatography

The change of retention of the steroid compounds with the change of the volume rate of the more polar component in the mobile phase is in accordance with the well known equation Eq. (1), Fig.1.:

$$\log k = \log k_0 - n \log \varphi \qquad (1)$$

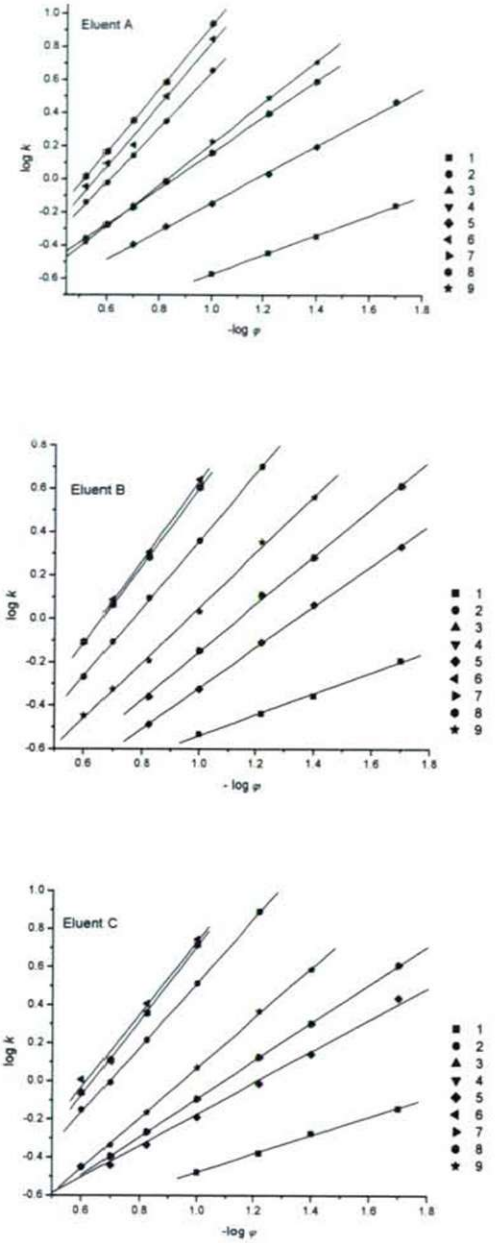


Figure 1. Correlation lines of equation (1), for eluents A-C. Designation of solutes is as in Table 1.

The coefficients log k_0 and n are presented in Table 2.

Table 2. Constants n and log k_0 of the linear relation between retention and eluents A-C composition. Designation of solutes is as in Table 1.

Compound	Eluent A		Eluent B		Eluent C	
	log k_0	n	log k_0	n	log k_0	n
1	-1.1650	0.590	-1.0256	0.486	-0.9632	0.484
2	-1.0253	1.674	-1.2036	1.563	-1.1858	1.699
3	-0.9965	1.930	-1.1918	1.795	-1.2577	1.967
4	-0.9965	1.930	-1.1918	1.795	-1.2577	1.967
5	-0.9998	0.586	-1.2621	0.941	-09999	0.824
6	-1.0562	1.885	-1.2070	1844	-1.1986	1.925
7	-0.9243	1.082	-1.2565	1.103	-1.0946	1.000
8	-0.9243	1.082	-1.2565	1.103	-1.0946	1.000
9	-1.0331	1.246	-1.2289	1.280	-1.2478	1.315

The correlation coefficients from linear regression analysis of experimental log k values varied from 0.9931 to 0.9999. On silica gel the retention sequence of 3-benzyloxy estrone derivatives obtained with non-polar eluents is that predicted on the basis of polarity of the compounds. The sequence of separation on the silica gel column with eluents A-C of all compounds is:

$$\mathbf{3 = 4 \geq 6 > 9 > 7 = 8 > 2 > 5 > 1}$$

The most retained compounds were compounds **3**, **4** and **6**. They are poorly or not resolved. Compounds **3** and **4** have in positions 16 and 17 polar =NOH and –OH groups. In same positions compound **9** has two –OH groups. Non polar 17α-methyl group of compound **4** did not affect retention on silica gel. The least retained compound was compound **1**. Compounds **7** and **8** were not resolved because the number of non-polar methylene groups in alkyl chain in position 17 did not affect the retention, and they always move together. Compound **9** always had a stronger retention then compounds **7** and **8**. With eluent B, the resolution of the midlle polarity compounds (**9**, **7**, **8**, **2**, **5**) was the best; the straight lines of all compounds did not intersect each other (Fig. 1).

The constant n in the equation (1) depends directly on polarity compounds. The more polar derivatives have higher values of the constant n and vice versa. The constant log k_0 is the value log k extrapolated to φ =1 and, therefore, no correlation was found between the constants n and log k_0.

3.2. Reversed- phase chromatography

The change in compounds retention of the steroid derivatives with increasing volume fraction of the modifier in aqueous mobile phases was in accordance with the well known equation, generally accepted in partition chromatography, Eq. (2):

$$\log k = \log k_0 - s\varphi \qquad (2)$$

where φ is the volume fraction of the organic component of the binary aqueous mobile phase, log k_0, is the value of log k extrapolated to φ = 0, and s is constant. The relationship between retention factor, log k, of the investigated compounds and volume fraction, φ, of the modifier in the aqueous mixture was linear, Fig. 2.

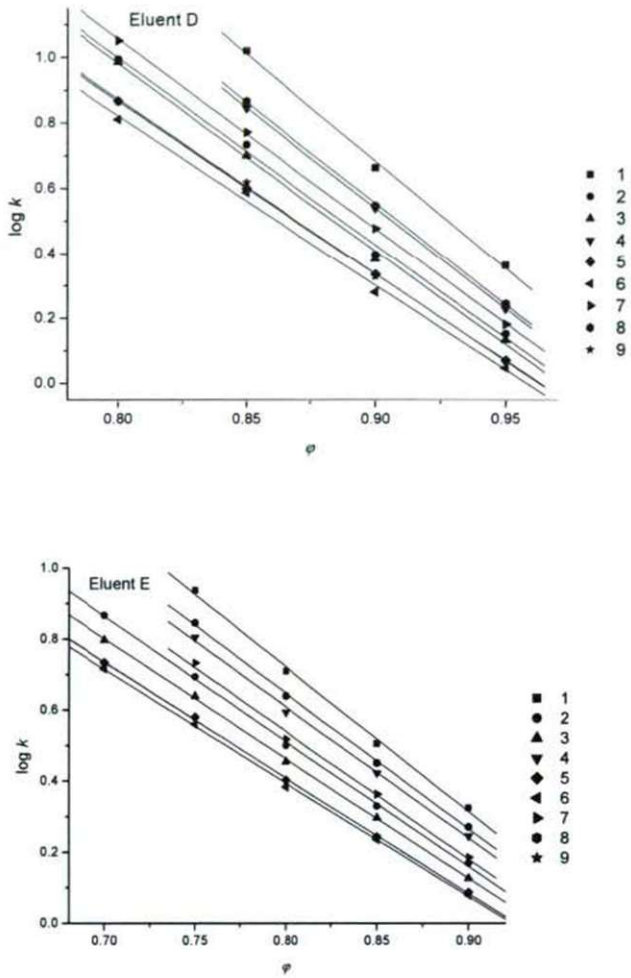


Figure 2.Correlation lines of equation (2), for eluents D and E. Designation of solutes is as in Table 1.

The compounds were more mobile in eluent with acetonitrile as the eluent modifier than with methanol owing to the lower polarity of acetonitrile. It is empirically known that a change from methanol to acetonitrile generally decreases the selectivity.

The numerical values of the absolute value constants s and log k_0 for each compound examined and mobile phases containing water and methanol or acetonitrile as modifier are given in Table 3. Correlation coefficients from linear regression analysis of experimental log k values varied from 0.9979 to 0.9999.

Table 3. Constants s and log k_0 of Equation (2) for the linear relationship between retention and mobile phases composition. Designation of solutes is as in Table 1.

Compound	Eluent D		Eluent E		Log *P*
	log k_0	-*s*	log k_0	-*s*	
1	6.6043	6.580	3.9907	4.086	5.375
2	5.5865	5.574	3.3324	3.526	4.724
3	5.5835	5.572	3.1624	3.374	4.909
4	6.0913	6.170	3.5709	3.702	5.356
5	5.1110	5.306	3.0204	3.264	5.489
6	4.9815	5.200	2.9530	3.198	4.809
7	5.7095	5.816	3.4181	3.598	6.022
8	6.1510	6.220	3.7101	3.828	6.527
9	5.1680	5.368	3.0120	3.254	6.309

The retention data obtained on C-18 bonded silica gel column are generally typical of reversed phase chromatographic behaviour: less polar solutes are more strongly retained. The retention order of the compounds with both aqueous mobile phases was very similar and increases in the following order:

1 > 8 > 4 > 7 > 2 ≥ 3 > 9 ≥ 5 > 6

Compounds **3, 4** and **6** as well as **7** and **8** which were not resolved on silica gel column were clearly resolved on C-18 bonded silica gel (Fig. 2), because retention of compounds is determined with hydrophobicity of compounds. Compounds **2** and **3** were poorly resolved because in reversed-phase the retention is determined by the benzyloxy function only, *i. e.*, the polar keto and hydroxy groups at position 17 did not affect the retention [3].

It is apparent from the data in Table 3 that on C-18 bonded silica gel column with both mobile phases the constant log k_0 and the absolute value of the constant *s* increase with increasing compound retention. There are, therefore, linear relationships between these two constants, with high correlation coefficients, Fig. 3.

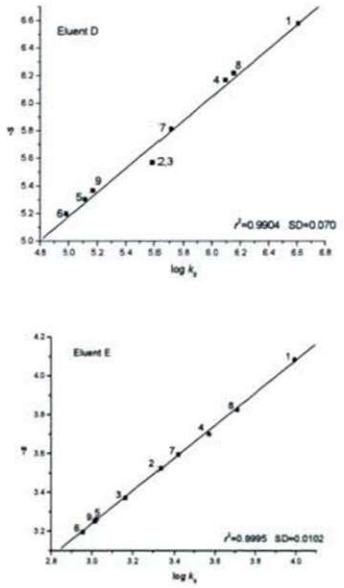


Figure 3. Plot of log k_0 against s for the mobile phases D and E. Designation of compounds is as in Table 1.

3.3. Correlation Between Retention Constant log k_0 of Steroid Derivatives Obtained on 7C-18 Column and log P

The intercept log k_0 corresponds to the retention in water as mobile phase, and represents the commonly employed chromatographic hydrophobicity parameter [10, 14].

With respect to the nine newly synthesized steroid compounds does not belong to the same series, therefore, no correlation was found between the constants log P (values log P are given in the last column of Table 3) and log k_0.

4. CONCLUSION

On silica gel the retention sequence of 3-benzyloxy estrone derivatives obtained with non-polar eluents is that predicted on the basis of polarity of the compounds. The change in steroid compounds retention with an increment of volume fraction of the stronger solvent in mobile phase is in accordance with the well know equation generally accepted in adsorbtion chromatography.

On octadecyl silica gel the retention sequence of the compounds obtained by applying aqueous-organic mobile phases, is basically the consequence of hydrophobicity of compounds. The change in compounds retention with an increment of volume fraction of the stronger solvent in mobile phase is in accordance with the well know equation generally accepted in partition chromatography.

For resolving of 3-benzyloxy estrone derivatives it is necessary to have one column of octadecyl silica gel and one column of silica gel. This combination guarantees resolution and makes possible quantitative determination of the steroid derivatives.

No correlation was found between the constants log P (values log P are given in the last column of Table 3) and log k_0, because nine newly synthesized steroid compounds does not belong to the same series.

ACKNOWLEDGEMENT

This work is a part of the Project No. 114-451-2373/2011, financially supported by the Provincial Secretariat for Science and Technological Development of Vojodina.

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A NEW CROP OPENS NEW WAYS FOR THE MILLING AND BAKING INDUSTRY

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ABSTRACT

Triticale (*Triticosecale* Wittm.) is a young, economical crop and its acreage has continuously been growing as the sustainability of farming is having superior status in all over the world. Today, triticale is a typical "on-farm" crop: farmers desire it as feedstock at their properties. Research reports however, revealed that this crop may be a useful, new ingredient in human consumption. This study is about the present situation and prospect of triticale production and utilization, particularly in human consumption. Lately, three environmentally sound triticale variety were developed in our institution for farmers for both low input, eco-production and conventional agronomical systems. In this study, we examined the most important milling and baking characteristics of these new triticale varieties.

Two of the tested triticales proved to have high alpha-amylase activities suggesting that using triticale component in target flour blends is desirable when improving the poor amylase activity of wheat components. The first Hungarian-bred spring triticale cultivar GK Idus has got exceptionally high kernel hardness as well as protein content. Thus, GK Idus can be used fairly in development of various whole mail cereals and confectionary industry. The results showed that all the tested triticales are suitable to use in human consumption, particularly to compose valuable flour blends using 10-50% triticale flour and 50-90% bread wheat flours as components. Triticale cultivar GK Szemes having exceedingly high loaf volume may be particularly valuable constituent in forthcoming baking industry.

1. INTRODUCTION

Triticale, the "human-made crop" developed by crossing wheat (*Triticum* sp. L.) and rye (*Secale cereale* L) is a young species if compare to its ancestors. The first crosses made at the end of the nineteenth century by botanist Wilson in Scotland, farmer Carman in the US, and breeder Rimpau in Germany. Actually, Rimpau was the first successful triticale breeder and his materials were used by subsequent researchers in many parts of the world (Ammar et al. 2004). In the last twenty five-year period (1988-2012), triticale has achieved an outstanding occupation in all over the world. The planting area of this crop has been steadily growing and according to the FAO statistics it reached over 4 million hectares by 2011. At the same time, the acreage of rye continuously decreased in recent decades. World rye production fifty years ago reached over 30 million-, while it decreased to 5 million hectares by today. In Hungary, triticale production started in late 1960's on sandy soil areas, in the middle regions of the country, around Kecskemet where A. Kiss exhibited his pioneer breeding efforts on this crop (Kiss, 1966, Kiss and Kiss, 1981). The results achieved by Arpad Kiss were outstanding ones: Triticale No. 57 and No. 64 the first ever released triticale varieties in the world were developed in Hungary (Zilinsky, 1985). Despite of the exceptionally successful breeding work, an adverse political-economical decision blocked the research, development and production of this crop in this country. In 1970, the authorities decided to terminate the extensive triticale breeding in Hungary. Kiss was forced to donate his valuable advanced materials to Polish scientists From that time, triticale breeding in Poland was enhanced substantially. Polish scientists has made tremendous efforts to improve adaptation of triticale (Bona and Kiss, 2002, Banaszak and Marciniak, 2002).

After a twenty year of 'silence', the revival of triticale production in Hungary started in the early 1990's. At this time, due to the political and economical changes in this region, the

renewing small family farms showed a strong interest in triticale. Small-holders and new private farmers discovered quickly the profitability of triticale - particularly on dry, poor, infertile soils. We continue our breeding activities on low-input varieties providing and environmental sound biological background for farmers and potential users in animal husbandry as well as in food industry. Based on this strategy, recently, three environmentally sound triticale varieties were developed in our institution suitable for feeding as well as for human food. Albeit, utilization triticale as human food is not a new idea (Salmon et al. 2002, Bona et al. 2002, Mc Goverin et al. 2011), till today, there is no role and regulation at any European Codex Alimentarus for grain and milled or crushed products on this crop. In this study, we examined the most important milling and baking characteristics of these new triticale varieties and also tested one winter bread wheat and one rye variety as controls.

2. MATERIALS AND METHODS

Recently released 2 hexaploid winter cultivars (GK Rege, GK Szemes) and a facultative-spring hexaploid cv. (GK Idus) were the subject of this study. Two control varieties were also incorporated (Jubilejnaja 50 /J-50/ winter wheat and Wibro rye). Grain samples were originated from the nursery field of our Experimental Station, Cereal Research Ltd., Szeged, Hungary, 2010 crop-year. Grain physical characteristics were identified by Perten SKCS 3100. Wet gluten, protein content and kernel hardness were tested by NIR and falling number (FN) of the entries was measured by Hagberg method. Probe loaves were baked and their parameters determined.

3. RESULTS AND DISCUSSION

Figure 1 shows that grain hardness of the tested entries positioned between 39 (rye cv. Wibro) and 96 (triticale cv. GK Idus). Triticale entries tested in this study were notably different from each other. GK Rege was similar to rye while and the GK Szemes reached the wheat hardness level. In this set, similarly its hardness the protein content of GK Idus was superior (data not shown). It suggest that special milled and crushed products may be elaborated when utilize the grain of this variety.

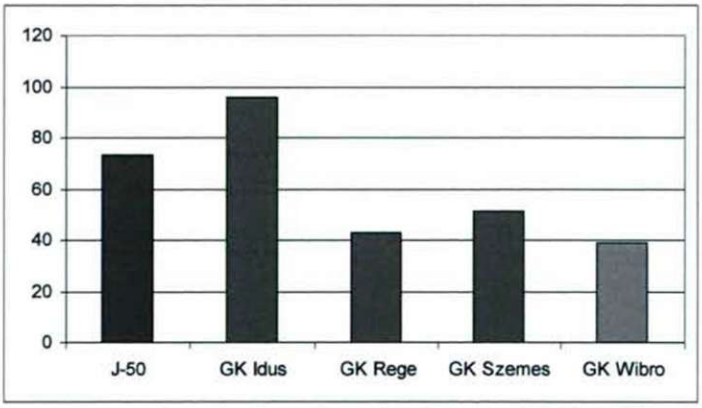

Figure 1. Grain hardness of cereal entries assessed in the study

Hagberg FN of the tested triticale entries ranged 122-357 s (Figure 2). The average of the triticale entries were similar to the rye entry. Records in the literature suggest that alpha amilaze activity of triticale generally high similar to rye (Boros 2006, Hajós 2007). Our

present data suggest that "enzyme-poor" wheat stocks such us J-50 in this study may be improved by using triticale addition to optimize blends. This study revealed that FN of some entries (i.e. GK Rege), however, can be as high as the average wheats.

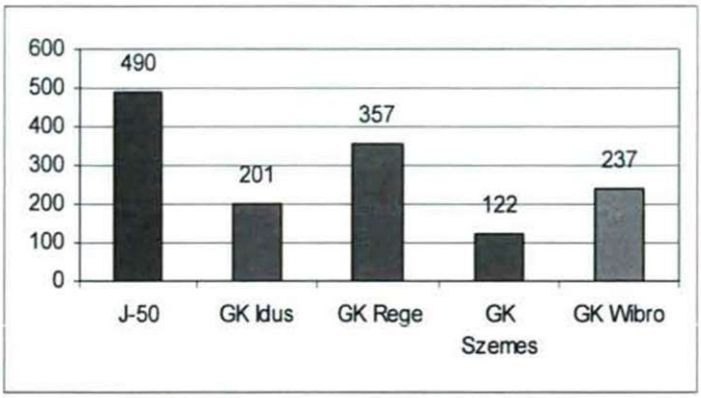

Figure 2. Formation of falling numbers of the tested triticale, wheat and rye entries

Wet gluten content of the flours ranged widely in this study. It was impossible to detect any gluten in the rye cv. Wibro, and with the exemption of GK Idus, poor wet gluten values were detected in triticale samples (data not shown).

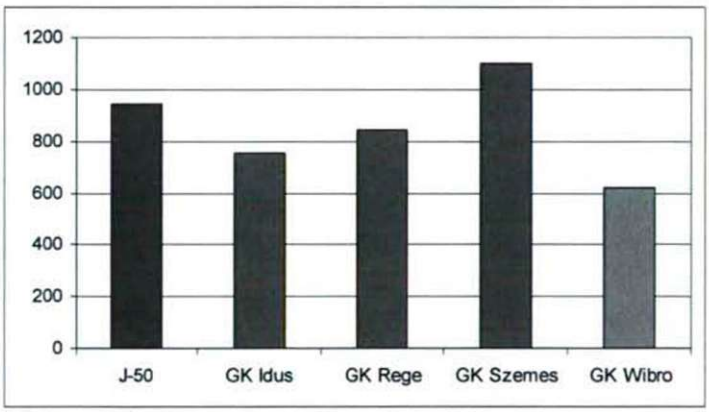

Figure 3. Volumes (cm^3) of the experimental loaves baked from the triticale and control varieties

The outcome of the experimental baking revealed that in spite of the poor gluten contents, triticale flours can be used in baking. Loaf volume of GK Szemes triticale reached an extremely high volume (Figure 3). The above results suggest that triticale flours may be used as valuable components when assembly high nutritional level flour blends for bread-making and other baking purposes. An extremely favorable textured bread can be baked when use the suggested triticale- wheat flour blend. Triticale variety GK Szemes has a prospect in bread making and general baking industry. Cultivar GK Idus may have a special legation in cookie and pasta industry and all of the tested entries may be used as good components in home economic purposes.

4. CONCLUSIONS

To date, the most common usage of triticale as a feed stock has been in poultry and hogs. It is obvious that the next major revolution in triticale breeding, production and utilization will be its innovation as human food. Based on our research, we recommend our recent triticale varieties for the cereal industry. Targeted triticale-wheat blends may be highly valuable food components in future cereal industry. Joint efforts of breeders and seed industrials, grain traders and millers, bakeries and food industrials will elevate the usage of triticale in human consumption and reach the consumer table with a healthy and high quality cereal food products.

ACKNOWLEDGEMENT

This study was partly sponsored by the Hungarian –Serbian IPA Croos-Border Cooperation Program (HUSRB/1002/214/045 "BIOCEREAL".

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EFFECT OF LYOPHILIZATION ON VOLATILES OF LEMON BALM LEAVES *(Melissa officinalis, L.)*

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ABSTRACT

Melissa officinalis is a part of the herbs with the high amount of volatile compounds. The losses of essential oils in lemon balm under freeze-drying depend mainly on drying parameters and conditions.

This research focuses on the analysis of the chemical component of essential oil of lemon balm. The essential oil of leaves was obtained by extraction. The chemical components of the essential oil of lemon balm were analyzed by capillary GC and GC/MS and 8 substances were identified.

The quality of the final product depends mainly on the operation of freeze dryer (FD). It was found that essential oil content was more influenced by chamber pressure (high and low). The higher chamber pressure causes a longer drying period but results better quality volatile compounds of lemon balm. Comparative determinations of the essential oil in fresh and dried material at high pressure showed slightly higher content of the oil in the fresh one.

The drying data were fitted to thin-layer mathematical model (third-degree polynomial). The performance of this model was investigated by comparing the determination of coefficient (R^2) and root mean square error (RMSE) between the observed and predicted moisture ratios.

1. INTRODUCTION

Lemon balm (*Melissa officinalis,* L.) a member of Lamiaceae family is a perennial herb native to southern climates of Europe and North America (Sharafzadeh et al., 2011).
The leaves of *Melissa officinalis* contain relatively low essential oil, but the production cost and price of the oil are very high (Sari and Ceylan, 2002). The volatile oil content depending on provenances, nutrient, light intensity, variety, plant part age, harvesting stages, harvesting hours, oil isolation method and the drying method (Moradkhani et al., 2010, Cuervo-Andrade, 2011). Conventional drying brings undesirable changes in medicinal herbs. It is caused by several modifications in the material (chemical, physical, biological) as a consequence of the removal of moisture and increase of temperature during the drying procedure. According to Enjalbert et al. (1983), the oil from dried lemon balm was darker in color, exhibited relatively lower concentrations of neral and geranial compared with the oil from fresh herb. Air-drying (temperature of 25-32°C for 10 days) caused a great reduction of antioxidant capacity of Melissa, reported by Capecka et al. (2005).

The development of new drying methods for medicinal herbs that allow reaching the required quality parameters. For example, the freeze drying can be used to avoid damage caused by heat, producing a product with superior physical and chemical qualities, it is considered a costly and time consuming process (Yousif et al., 2000).

The chemical constituents of volatile oil have been extensively studied. More than forty compounds were recognized in Melissa oil (Patora et al., 2003). Meftahizade et al. (2010) reported, that the main component of the essential oil in lemon balm leaves are citral (geranial and neral), citronellal, geraniol, beta-pinene, alpha-pinene, beta-caryophyllene, comprising 96% of the oil ingredients. The major compounds were citronellal and citral, accompanied by beta-caryophyllene, germacrene D, ocimene and citronellol, reported by Nykanen and Nykanen (1986).

Lemon balm has been traditionally used for different medical purposes, food preparation, cosmetics.

There are many previous studies conducted on drying of various products. However, studies on drying characteristics of the lemon balm leaves are scarce in the literature. Moreover none of them reports about freeze drying kinetics and the effects of this drying technique in terms of chemical components of essential oil.

The aim of this study was to evaluate the qualitative and quantitative composition of volatile oil of the lemon balm. The effect of the pressure (high: FD-HP and low: FD-LP) of the freeze-drying procedure was also investigated.

2. MATERIALS AND METHODS

2.1. Raw material

The lemon balm was cultivated locally in Nyíregyháza and the plants were harvested just before flowering in June 2011. Fresh leaves were separated from the stem and only leaves were used for the drying and extraction of the oil. Essential oil was separately extracted from fresh leaves, freeze dried leaves at high pressure and freeze dried leaves at low pressure with three replications. The oil was identified by the staff at the Agrarian and Molecular Research Institute College of Nyíregyháza. The total amount of essential oil recovery was calculated in mg/100g based on the dry matter. The moisture content of fresh lemon balm was 5.09 kg water/kg dry matter (83.58% moisture content wet basis).

2.2. Determination of moisture content

To determine the moisture content of *Melissa officinalis* before and after freeze drying, the oven method (LP-306, LABOR-MIM, Hungary) was used. In this method the sample is placed inside and oven at 105°C for 24 h and the loss of mass is registered in order to determine the moisture content of the lemon balm. The test was carried out for triplicate.

2.3. Gas chromatography of the essential oil

Determinations of the volatile oil contents were done by chemical extraction (Moradkhani et al., 2010). About 50 g of fresh and ~9,5 g of dried plant leaves were subjected separately to extraction. The extraction procedure consisted of adding chloroform/hexane solvents (1:1, 600 ml) to the lemon balm samples, then mixing, blending and the ultrasonic homogenization of the sample (1 h, 40°C), followed by filtration and the release of solvent by rotating vacuum evaporation. The solvent was diluted with chloroform/hexane (1:1.5 ml) to allow for the release of chlorophyll with Al_2O_3. The remaining steps involved spraying the mixture with nitrogen gas, diluting the solvent with hexane (1 ml). A total of 1 µl of the extract was injected into the GC.

The oil was analyzed by Gas Chromatography (GC) and Gas Chromatography-mass Spectrometry (GC/MS). GC analysis was carried out on a Thermo Scientific Trace GC Ultra TG-5SILMS capillary column (30m×0.25mm, 0.25µm film thickness). The chromatographic conditions were as follows: The oven temperature increased from 40 (1 min) to 220°C (1 min) at a rate of 15°C/min, analysis time 14 min. The injector and detector temperature was 250°C. Helium used as the carrier gas was adjusted to linear velocity of 1.5 ml/min. The samples were injected using CT splitless method. Analytical standards of the flavour principles were obtained from Sigma-Aldrich. Quantitative data was obtained from electronic integration of peak areas without the use of correction factors.

GC/MS analysis was performed on a Thermo Scientific Trace GC Ultra-MS ITQ 1100 operating at 70eV ionization energy. It was equipped with a TG-5SILMS capillary column

(30m×0.25mm, 0.25μm film thickness) with *Helium* as the carrier gas and a parameters of constant splitless injection: Temperature – 250°C, split flow – 10 ml/min, splitless time – 1 min. The temperature of MS transfer line: 270°C. The components of the oils were identified by both retention times and MS spectra. The result was an average of three determinations.

2.4. Drying procedure

The lemon balm leaves were lyophilized by freeze drying (FT33, Armfield, England). The product was dried for a period of 14 h at 200-300 Pa (FD-HP) and for 12 h at 50-80 Pa (FD-LP) with the heating plate kept at 18°C. The condenser temperature was kept at –50 to –55°C. A special digital weighing apparatus (EMALOG, Hungary, accuracy of 5000 ±0.1 g) measures the mass loss of the product during the freeze drying process. During each drying experiment, the weight of the samples on the tray was measured. The tests were repeated three times. The final moisture content of dried lemon balm leaves: 0,15 kg water/kg dry matter (10.92% moisture content wet basis).

2.5. Mathematical modelling of drying curve

The third-degree polynomial equation (1) is the most convenient mathematical model of freeze drying kinetics and has been used in thin layer drying studies (Antal, 2011).

$$MR = at^3 + bt^2 + ct + d \quad (1)$$

The values of parameters *a, b, c, d* of the third-degree polynomial depend on the characteristics of the material, including variety, freezing rate, ripeness, and tendency to lose water (Antal et al., 2011).

The moisture ratio (MR) of lemon balm during drying experiments was calculated using the following equations (2):

$$MR = \frac{M - M_e}{M_0 - M_e} \quad (2)$$

where, MR is dimensionless moisture ratio, M is moisture content dry basis (kg water/kg dry matter), M_e is equilibrium moisture content dry basis (kg/kg db), M_0 is initial moisture content dry basis (kg/kg db).

The sample moisture content M was calculated on a dry basis (db) according to equation (3):

$$M = \frac{W_t - W_k}{W_k} \quad (3)$$

where, M is moisture content dry basis (kg water/kg dry matter), W_t is sample weight at a specific time (kg), W_k is sample dry weight (kg).

The correlation coefficient (R^2) was primary criterion for selecting the best equation to describe the drying curve equation. In addition to R^2, the root mean square error analysis (RMSE) was used to determine the goodness of the fit (4, 5).

$$R^2 = \frac{\text{Residual sum of squares}}{\text{Corrected total sum of squares}} \quad (4)$$

$$RMSE = \sqrt{\frac{1}{N} \cdot \sum_{i=1}^{N} (MR_{\exp_i} - MR_{pre_i})^2} \quad (5)$$

where, $MR_{exp,i}$ is the experimental moisture ratio at observation, $MR_{pre,i}$ is the predicted moisture ratio at this observation, N is number of observations. The lower RMSE values and the higher R^2 values indicate the high fit of the model.

2.6. Statistical analysis

Tukey's test was used to determine significant differences ($p<0,05$) between the three types of lemon balm (fresh, FD at high pressure, FD at low pressure). The statistics package chosen was PASW Statistics version 18.0 (SPSS Inc., USA). The software package Microsoft Office Excel 2007 was used in the numerical calculations.

3. RESULTS AND DISCUSSION

3.1. Drying kinetics

The dimensionless moisture content (MR) change during freeze drying is presented in Figure 1. In this figure the experimental data and the mathematical modelling of the drying kinetics experimental data for lemon balm samples are also shown.

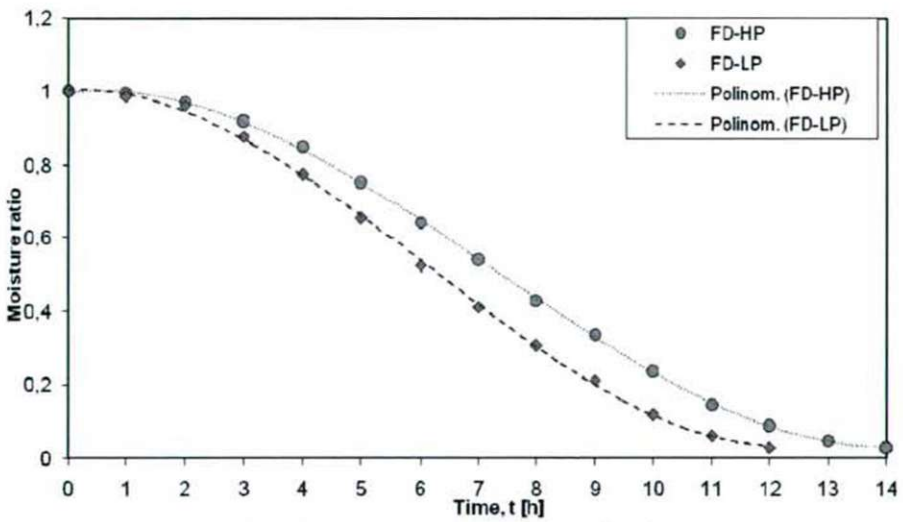

Figure 1. Moisture ratios versus time at various chamber pressures

This figure shows higher drying rate when the sample is dried at low chamber pressure (FD-LP). The final moisture content for *Melissa officinalis* was found to be about 0,15 kg water/kg dry matter (db) after 12 and 14 hours of drying time for FD-LP and FD-HP samples, respectively. The final dimensionless moisture content of the products for FD-LP and FD-HP samples were 0.029. Thus, FD-HP samples required 2 hours longer drying time to achieve the same final moisture content compared to FD-LP Melissa samples.

The Table 1 shows the drying model coefficients and the comparison criteria used to assess quality of fit. The statistical values, R^2 and RMSE, are also shown in Table 1. The R^2 and RMSE values changed between 0.9994 and 0.9998, 5.24×10^{-3} and 1.022×10^{-2}, respectively. So, the model could be used to describe the drying of lemon balm leaves.

The drying kinetics results showed that there is a good agreement between the experimental data and thin-layer modelling equations. As shown in Table 1, the highest value

of coefficient of determination (R^2>0.999) and the lowest value of the root mean square error less than 1.022×10^{-2} predicted by third-degree polynomial's model for Melissa samples.

Table 1. Effect of drying conditions on model parameters

Drying method	*Model name*	*Model parameters*					
		a	b	c	d	R^2	RMSE
FD-HP[1]	*Polynomial*	0,0008	-0,0177	0,0187	0,998	0,9998	0,00524
FD-LP[2]		0,0012	-0,0213	0,0089	1,0046	0,9994	0,01022

[1] Freeze dried at high pressure
[2] Freeze dried at low pressure

This model can be used satisfactorily to predict the experimental values of the moisture ratio values.Our previous results indicate that in the case of the freeze drying the polynomial model gives the most accurate fit (Antal et al., 2011).

3.2. Identification of essential oil components

The chemical composition of lemon balm oil was characterized by Gas Chromatography (GC) and GC/MS analysis. In Figure 2 the chromatogram of fresh lemon balm leaves essential oil are presented from mass spectral data. The principal components of volatile oil of the leaves: citral, beta-caryophyllene, beta-cis-ocimene, alpha-calacorene.

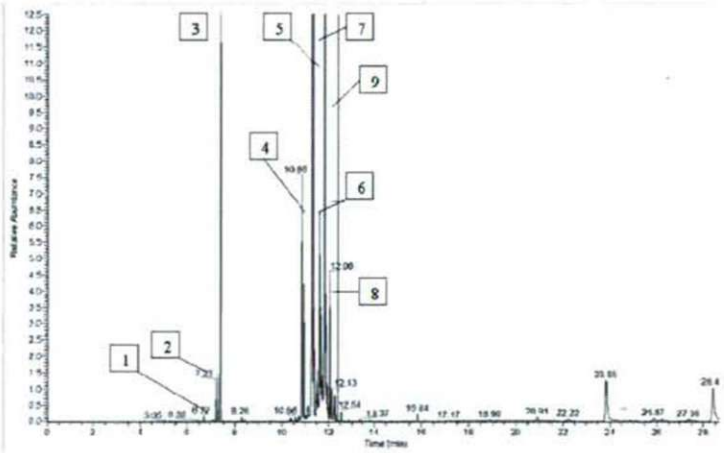

Figure 2. Gas-Chromatogram of volatiles extract from fresh 'Melissa officinalis'
The peaks correspond to identified compounds: (1) β-pinene, (2) limonene, (3) β-cis-ocimene, (4) α-cubebene, (5) β-caryophyllene, (6) α- caryophyllene, (7) citral, (8) δ-cadinene, (9) α-calacorene

Table 2 presents the results of GC in the fresh and lyophilized lemon balm oil. The major volatiles found were citral, citronellal, geraniol and limonene. The main composition of the fresh leaf essential oil agreed with the data of the previous authors (Carnat et al., 1998, Schnitzler et al., 2008).

The total concentrations of volatile compounds in fresh, FD-HP and FD-LP lemon balm samples were 0.293, 0.252, and 0.191 respectively. The components of Melissa oil were identified by authentic terpene standards (we have only eight standards).

Table 2. Volatile compounds of lemon balm leaves

Components [mg/100g db]	*Concentration*		
	Fresh	*FD-HP[1]*	*FD-LP[2]*
Citral	123,65[a]	108,34[b]	81,59[c]
Citronellal	77,33[a]	66,56[b]	54,90[c]
Geraniol	29,12[a]	28,02[a]	16,88[b]
Limonene	23,79[a]	17,89[b]	12,13[c]
β-citronellol	14,87[a]	10,32[b]	9,64[b]
β-pinene	11,48[a]	10,62[ab]	6,91[b]
Linalool	10,23[a]	8,74[ab]	6,85[b]
Terpineol	2,53[a]	2,27[a]	2,09[a]
Total [%]	0,293[a]	0,252[b]	0,191[c]

[1] Freeze dried at high pressure
[2] Freeze dried at low pressure
[abcd] Different letters in the same row indicate statistical differences at the 0,05 level according to the Tukey's test.

Our study revealed that FD-HP samples retained most of the compounds significantly better than FD-LP samples. This means that the concentrations of essential oils in the FD-processed herb decreased with a reduction of pressure in the drying chamber of the freeze dryer.

4. CONCLUSIONS

The volatiles composition of freeze dried lemon balm under different conditions of pressure has been studied. Essential components for the *Melissa officinalis* were detected in fresh samples as well as in dried ones. The essential oil of the fresh material was higher than of the dried one. The quality of lemon balm extract obtained from FD-HP (freeze dried at high pressure) samples was found to be superior, as compared to that of FD-LP (freeze dried at low pressure) samples. From the drying kinetics result, the FD-LP lemon balm leaves had shorter drying time than the FD-HP samples.

A decrease in drying chamber pressure significantly decreased the freeze-drying time of the lemon balm leaves but considerably increased the release of volatile compounds.

The third-degree polynomial equation has shown a very well fit to experimental data. The model gave R^2 of 0.9998 and RMSE 5.24×10^{-3} for FD-HP samples and R^2 of 0.9994 and RMSE 1.022×10^{-2} for FD-LP samples in the thin layer freeze drying process. According to the results, the polynomial equation could adequately describe freeze drying characteristics of lemon balm leaves.

We recommend the drying of lemon balm leaves by freeze drying and the pressure in the drying chamber should not be too low.

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SURFACE COMPLEXATION MODEL OF AQUIFER POLLUTION WITH HEAVY METALS ON AN ASH AND SLAG DUMP NEAR TIMIŞOARA

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ABSTRACT

For modelling of the pollutants transport process in aquifer a very important aspect has the analysis of aquifer pollution with heavy metals. The surface complexation process of heavy metals on the grains of porous-media is reversible similar to the adsorption-desorption in transport processes, in aquifer pollution, but strongly dependent of pH value. High pH values determine increasing heavy metals complexation and consequently decrease their concentration in the groundwater. Decreasing pH value leads to liberation of heavy metals from the formed complex and so an increased concentration of heavy metals in the groundwater appears. This paper presents the results obtained by using a numerical experiment using PhreeqC and PMWIN software package for the spreading of the heavy metals pollution in the aquifer of an ash and slug dump, as pollution source, near village Utvin, Timiş County, Romania.

1. INTRODUCTION

It is known that heavy metals are metals with a higher density than $\mu g/m^3$. These metals as well as their residues are pollutants in the environment; some of them are even toxic. Some of these elements are actually necessary for humans in minimal amounts (cobalt, copper, chromium, manganese, nickel) while others are carcinogenic or toxic, affecting, among others, the central nervous system (manganese, mercury, lead, arsenic), the kidneys or liver (mercury, lead, cadmium, copper), the skin, bones, or teeth (nickel, cadmium, copper, chromium).

Mentioned items that reach the aquifer are spread by advection, dispersion and other transport processes. Heavy metals found in the environment have the ability to form complexes on the surface of particles; this process is known as surface complexation. This process is influenced by different parameters, but we study only the influence of pH.

The process of surface complexation is shown schematically in the following Fig.:

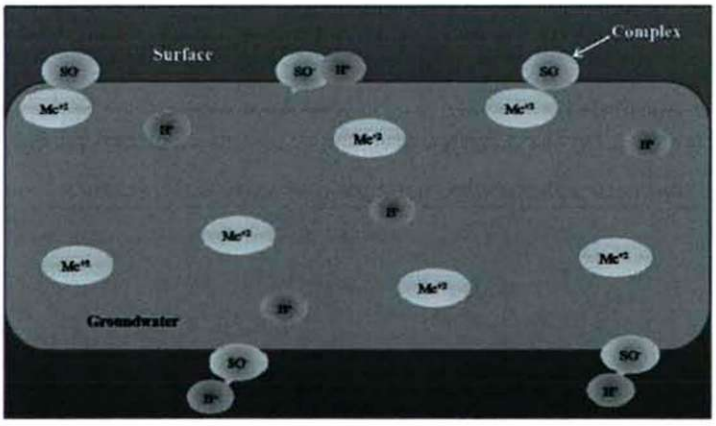

Figure 1. Surface complexation model

The reactions responsible for surface complexation presented in Fig. 1 can be written:

$$SOH_2^+ \Leftrightarrow SOH^0 + H^+$$

$$SOH^0 \Leftrightarrow SO^- + H^+$$

$$SOH_0 + Me^{2+} \Leftrightarrow SOMe^+ + H^+$$

The surface complexation is reversible, meaning that the complex bands can decay if the environmental conditions change.

2. TOOLS, DATA AND DOMAINS

2.1. Modelling tools

Surface complexation is highlighted by the software PhreeqC that enables forecasting chemical processes that occur naturally in studied aquifers. PhreeqC version 2 (Parkhurst, D. L., Appelo, C.A.J., 1999) uses mole fraction for the activity of surface species. Surface complexation processes are included in the model through heterogeneous mass-action equations, mole-balance equations for surface sites, and charge-potential relations for each surface.

For transport modelling, meaning spreading of pollutants in aquifer, which in our case are heavy metals are modelled using PMWIN, a MODFLOW based software (Chiang, W.H., Kinzelbach, W., 2001). MODFLOW is a simulation system for modelling groundwater flow and pollution transport processes. This software allows modelling of underground water flow and extension of pollutants plume in aquifer in space and time.

2.2. Data

All data used were provided by CET SUD Timişoara, and it represents the analysis performed during the years 2007-2010 from wells of the slag and ash dump. Wells from which samples were taken are represented in Fig. 2, and they are marked with: PJ1, PJ2, PJ10, PJ11 and PJ12.

For our study we used an average concentration of heavy metals. Average was calculated for 2010, because these were the last analysis results we obtained at this moment.

2.3. Analysed Domain

The analysed site is a slag and ash dump located near Utvin village in Timiş county. There we find stored ash and slag produced from the combustion of coal at CET SUD. Coal combustion is used to produce heat and domestic hot water, provided to Timişoara City. Utvin slag and ash dump is a deposit of lowland, which occupies an area of 150 hectares. The dump has a trapezoidal form with the large base of 1100 m, a lower base of 900 m and the trapezoidal height of 500 m.

The dump is located at:

- 1,5 km SW of Utvin Village
- And about 4 km West of Timişoara City

The dump is located at approx. 2 km SE of Bega River and near the Nivelda creek, which passing approximately 500 m south of the deposit.

The deposit is designed for a total capacity of 4 821 000 m^3. (Ministry of Environment and Sustainable Development, 2008)

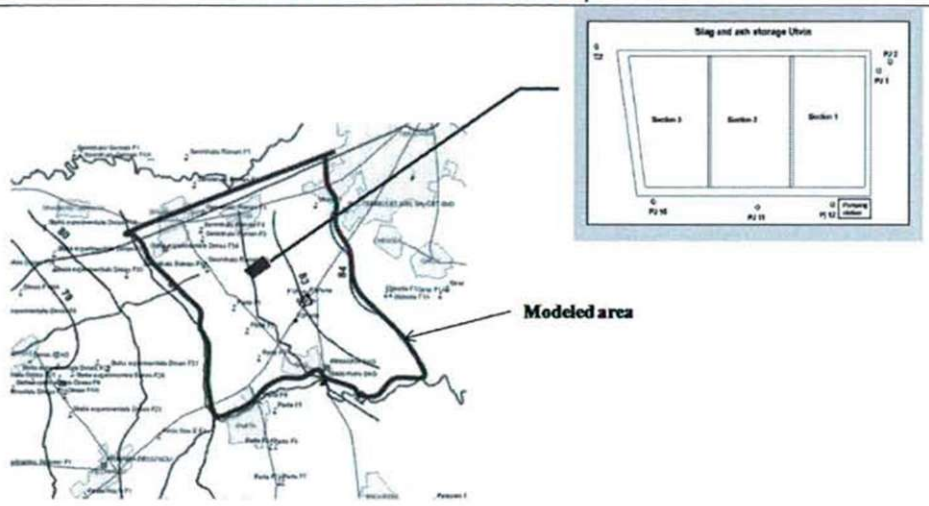

Figure 2. Localization and shape of the studied slag and ash dump *(David I. et all, 2007)*

Waterproofing system

According to the hydro geological survey, slag and ash dump Utvin is located on a clay layer of 3,5 to 6,5 m thickness, which has an average permeability of k = 0,05 m / day (k = 5 x 10^{-5} cm/s).

3. RESULTS

The first step of the research was to determine surface complexation at different pH values using PhreeqC software. The results obtained are shown below.
Molality at different pH values:
Initial concentration of Zn is 0,001898 mol/kg. We can see in Fig.3 that the concentration decreased with increasing pH: for a pH of 8,5 the Zn concentration become 0. That indicates that it has been fixed entirely by surface complexation.

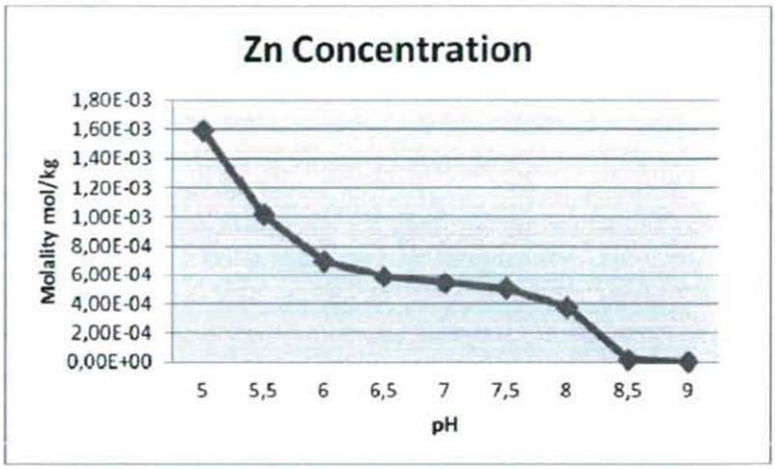

Figure 3. Zn Concentration of Zn at different pH values

In the case of lead we started from a lower concentration than zinc, namely 0, 00003943 mol/kg. Initial concentration was lower but in Fig. 4 we can see that removing the whole quantity of Pb from the groundwater, by surface complexation, is reached at pHvalue of 8,5.

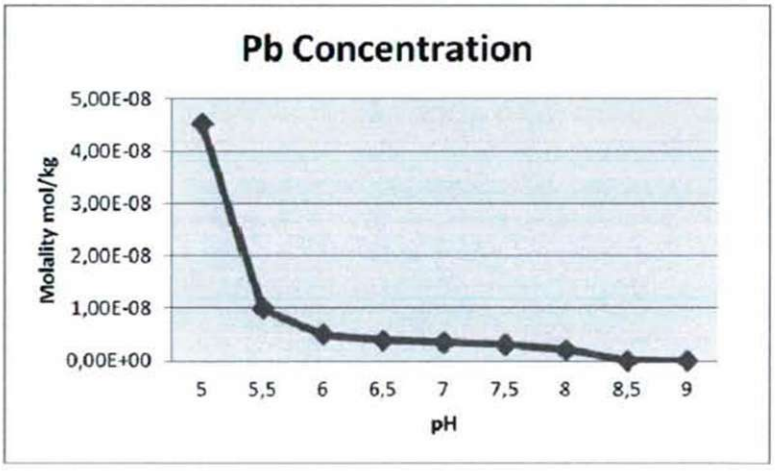

Figure 4. Concentration of Pb at different pH values

Copper appeared with two different valences, (1) and (2), the concentration of these two forms being 0, 00000005157 mol / kg Cu (1) and 0,000001074 mol / kg Cu (2). Cu (2) behaves like Zn and Pb, meaning that at a pH value of 8,5 it reaches a concentration of 0 in solution. But in contrast Cu (1) disappears at a pH value of 8, but this may be due the small amount of Cu (1) of the solution. Fig. 5 is a graphic representation of the two concentrations Cu (1) and Cu (2) and their evolution in function of pH.

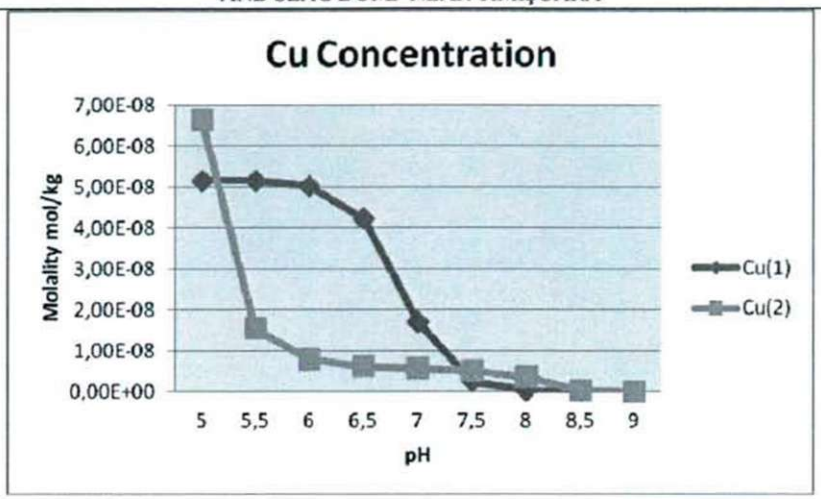

Figure 5. Concentration of Cu (1) and Cu (2) at different pH values

The 4-th studied element is cadmium. In this case we start the study at a concentration of 0.0001444 mol / kg. We can see in Fig. 6 that this heavy metal, Cd, is removed from the groundwater, and fixed by surface complexation at a pH value between 8.5 and 9. This indicates that Cd disappears later from the aquifer than previously studied items. The difference is not great but is visible.

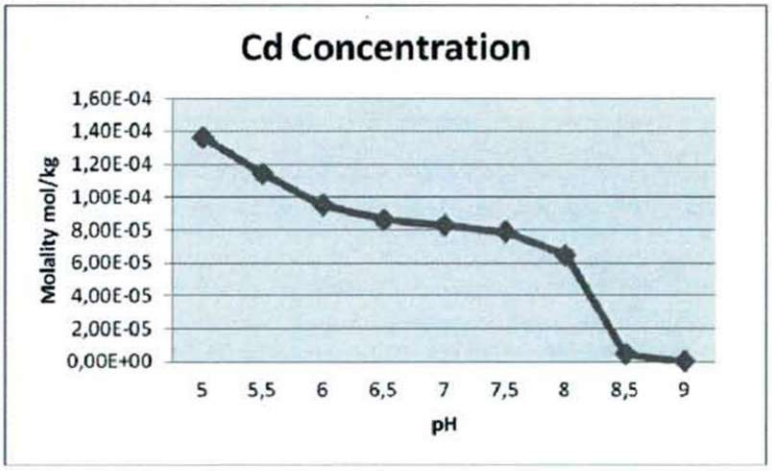

Figure 6. Cd concentration at different pH values

The next step of the study was to introduce the data, obtained using the software PhreeqC, in the development of a transport model using PMWIN. The stabilised heavy metals concentration under the pollutant source (*ash and slug dump as pollution source near village Utvin, Timiş County, Romania)* determined by the pH value can be used as a fixed boundary concentration for modelling the spreading of the heavy metals pollution in the aquifer.

By creating a model based on obtained data we want to show, that the fixation of heavy metals by surface complexation, leads to modified spreading of pollution into the environment.

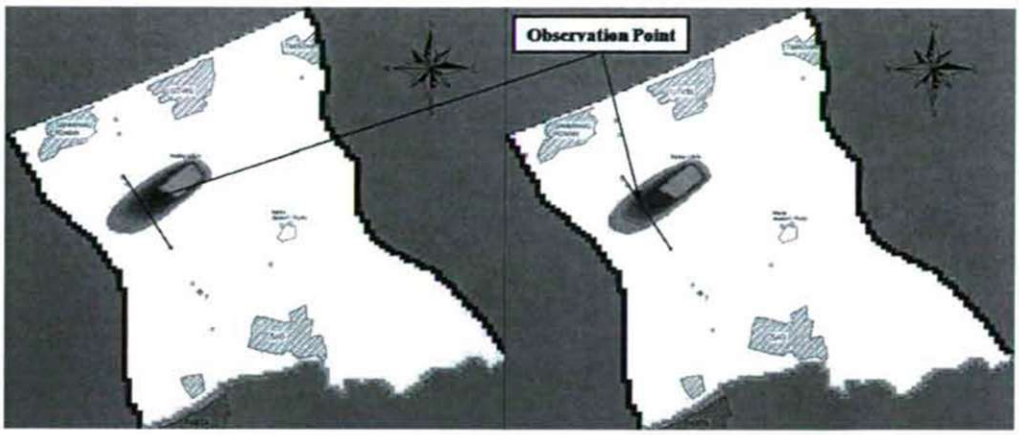

Figure 7. Pollution plum after 30 years (initial concentration and pH=7,)

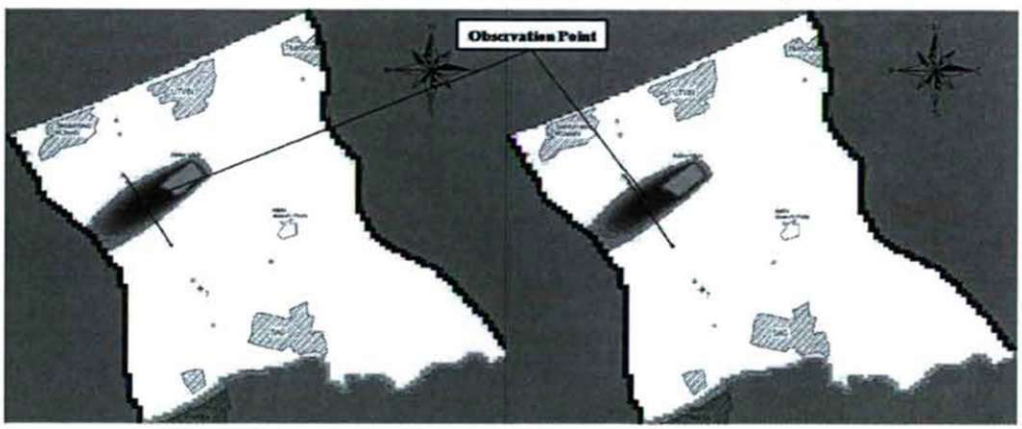

Figure8. Pollution plum after 50 years (initial concentration and pH=7)

The obtained differences by surface complexation are not that visible. For this reason we used an observation point in which, with the use of PMWIN software, we can highlight the space and time evolution of pollutant concentrations. (Fig. 9)

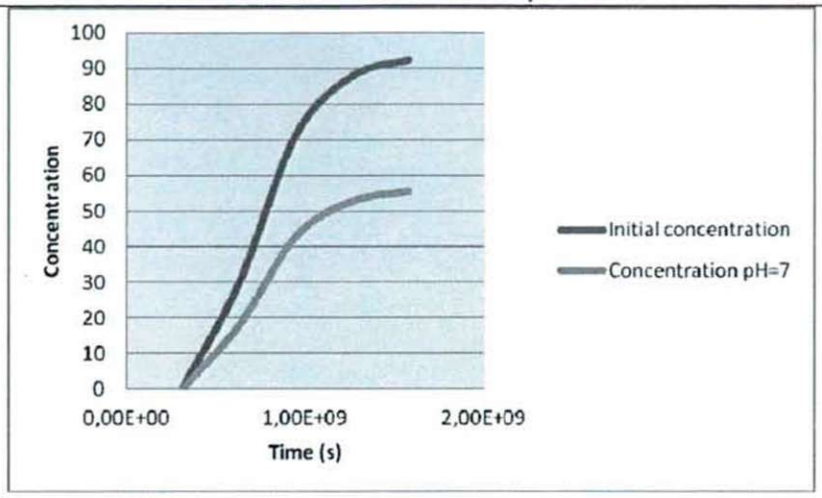

Figure 9. Concentration in the observation point after surface complexation

4. CONCLUSION

Based on PhreeqC modelling relevant conclusions can be formulated on the state of heavy metals concentration in the groundwater.

The surface complexation process of heavy metals on the grains of porous-media in the aquifer is reversible similar to the adsorption-desorption transport processes but strongly dependent of pH values. High pH values determine increasing heavy metals surface complexation and consequently decreased concentrations in the groundwater. Decreasing pH value leads to release of heavy metals from the formed complexes and so an increased concentration of heavy metals in the groundwater appears. At pH values between 8 and 8,5 we found out that the concentration of heavy metals have minimum values (Fig. 5-6). Having a pH value of 8.5 reduces heavy metals concentration to zero (0). Thereby an alkaline pH favours the surface complexation process. In order to forecast the evolution of pollutant plume we must take into consideration natural attenuation and surface complexation as a part of these natural processes which takes place without the application of engineering technologies. Only such we can determine true and correct the concentrations under the source of pollution which are the essential boundary conditions needed for modelling pollutant extension.

Fixing processes of heavy metals described above can be considered natural attenuation only if a stabile natural pH value is maintained in order to avoid the reversibility of surface complexation processes.

Monitoring of contaminated sites can reduce the threat to environment, because by exact monitoring we reduce the risk of unwanted events. In case unwonted situation would appear we can take action soon to remove the danger to human health and the environment.

ACKNOWLEDGMENT

This work was partially supported by the strategic grant POSDRU/88/1.5/S/50783, Project ID50783 (2009), co-financed by the European Social Fund – Investing in People.

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NUMERICAL MODELLING OF MICROWAVE DRIED POTATO FLAKES

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ABSTRACT

During the research was developed using the commercial software Ansoft HFSS (High Frequency Structure Simulation) a numerical modeling of a microwave system having as a dielectric material the potato flakes. Using numerical modeling software's there can be simulated the dielectric products to test appropriate microwave treatment control strategies.
Keywords: Ansoft HFSS, microwave drying, dielectric properties, numerical modeling

1. INTRODUCTION

Microwaves are electromagnetic waves in the frequency band from 300 MHz (3×10^8 cycles/second) to 300 GHz (3×10^{11} cycles/second) (Hathazi and Maghiar, 2003). Microwave processing materials at industrial level Industrial microwave processing is usually done at the frequencies set aside for industrial use, 915 MHz, 2.45 GHz, 5.8 GHz, and 24.124 GHz (Maghiar and Soproni, 2003), (Metaxas and Meredith, 1983).

The process of drying materials in the microwave field has become a new, powerful, and significantly different tool which has significant advantages in front of the drying conventional methods (Metaxas and Driscol, 1974), (Molnar et al, 2008). The conventional heating methods require heat conduction from the material's surface inward, they are slow and inefficient for materials that conduct heat poorly (Khraisheh, 2004).

The application of microwave energy to the processing of various materials such as ceramics, metals and composites offers several advantages over conventional heating methods (Nelson, 1995). These advantages include unique microstructure and properties, improved product yield, energy savings, reduction in manufacturing cost and synthesis of new materials (Das et al, 2009).

First controlled and used during the second world war in radar systems, the usefulness of microwaves in the heating of materials was first recognized in 1946 (Soproni et al, 2009). Raytheon introduced the first microwave oven to the marketplace in 1952. A large investment has been made over many years in the development of microwave processing systems for a wide range of product applications (Sablani and Mujumdar, 2006) (Phillippy, Mengshi and Rasco, 2004).

2. MATERIAL AND METHODS

Dielectric properties of food materials depend on many factors, including frequency of the microwaves, food temperature, moisture content, salt content, and other constituents (Juming Tang, 2012). In a food system, the change of dielectric properties with respect to temperature depends upon frequency, bound water to free water ratio, ionic conductivity, and composition of the material (Szabo, Rajko and Hodur, 1998). For example, at microwave frequencies used by the food industry, both the dielectric constants and the loss factor due to polarization of bound water in foods would increase with temperature. On the other hand, these two properties of free water would decrease when temperature increases (see fig.1) (Juming Tang, 2012).

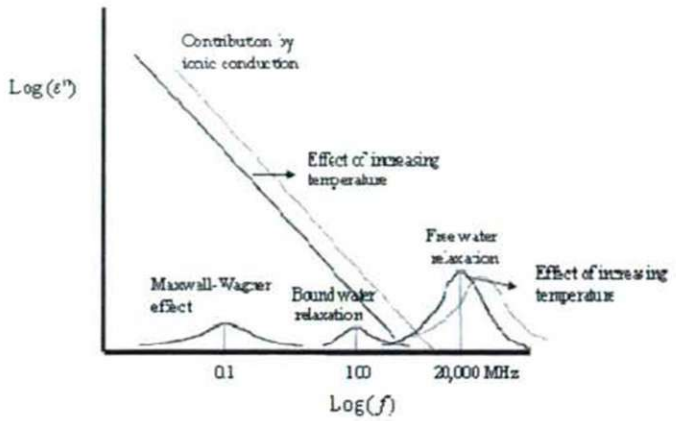

Figure1. Contributions of various mechanisms to the loss factor of moisture materials as a function of frequency and temperature (Juming Tang, 2012)

The dielectric properties of materials are being described by the complex relative permittivity, ε^*, which is represented with the next relationship:

$$\varepsilon^* = \varepsilon' - j\varepsilon'' \quad (1)$$

where $j = \sqrt{-1}$;

ε' represents the dielectric constant and is the ability of the material to store electric energy when in an electromagnetic field;

ε'' represents the imaginary part, it is the dielectric loss factor and influences the conversion of electromagnetic energy into thermal energy.

The ratio of the real and imaginary parts of permittivity represents the tangent of loss angle $\tan\delta = \varepsilon'/\varepsilon''$ which along with the dielectric constant determines the attenuation of microwave power in foods.

In the electromagnetic field, the amount of thermal energy converted in food is proportional to the value of the loss factor ε''. The increase in temperature (ΔT), without consideration of heat transfer, can be calculated from:

$$pC_p \frac{\Delta T}{\Delta t} = 5.563 \times 10^{-11} fE^2 \varepsilon'' \quad (5.563*10^{-11}=2\pi\varepsilon_0) \quad (2)$$

where

$C_p (Jkg^{-1}{}^0C^{-1})$ is the specific heat of heated material;

$\rho(kg\ m^{-3})$ is the density;

$E(Vm^{-1})$ is electric field intensity

f(Hz) is frequency

$\Delta t(s)$ is time increment

$\Delta T(^0C)$ is the temperature rise (Schubert and Regier, 2005).

The most important vegetable crop, the fourth as importance in the world is the potatoe and the main utilization of processed potatoes includes table stock (31%), frozen French fries (30%), chips and shoestrings (12%), and dehydrated items (12%) (Miranda and Aguilera, 2006).

The chemical composition of potato varies with cultivar, location of growth, agricultural practices, maturity at harvest, and subsequent storage history, among others. Potatoes are mainly made up of water (75% on average) (Friedman, 2003).

3. RESULTS AND DISCUSSIONS

In the process of developing technologies based on microwave energy, an important step is creating experimental models, lab, that could permit a real analyze of the phenomenon's in any moment and conditions of the heating process with microwaves and also determining the specific parameters of the problem.

The existence of special software's permit that before practically making an installation, it can be numerical simulated. In this way when creating the installation there will be known a part of the phenomenon's that characterize the installation, and so there will be eliminated some of the unknown's of the problem.

The existing resonant cavity was numerically simulated using the commercial software Ansoft HFSS, and the obtained results are being presented below.

The monomod aplicator has a parallelipiped shape, made of aluminium walls and is being excited by a magnetron at a frequency of 2.45GHz. Electromagnetic waves transmission from the magnetron to the cavity is being made through a rectangular waveguide, in which prolongation is placed the applicator.

The commercial software Ansoft HFSS is a interactive software that allows electromagnetic field determination inside passive structures at high frequencies. ANSYS is the leading provider of electromagnetic field, circuit and system simulation software for the design of high-performance electronic equipment and electromechanical devices.

For analyzing the electromagnetic field inside the microwave installation, were homogenized 100g of potato flakes with 600 ml of water in a plastic recipient, that was preliminary weighted and than the composition was introduced in the microwave at a variable power, processing time being of 5 minutes.

Accordingly to the specialty literature the values for the relative permittivity and loss factir for wet potato flakes at a temperature of 20° are $\varepsilon' = 0{,}62$ and $tg\delta = 0{,}354$. Below are being presented the obtained results after simulating the heating process of the wet potato flakes in the microwave field.

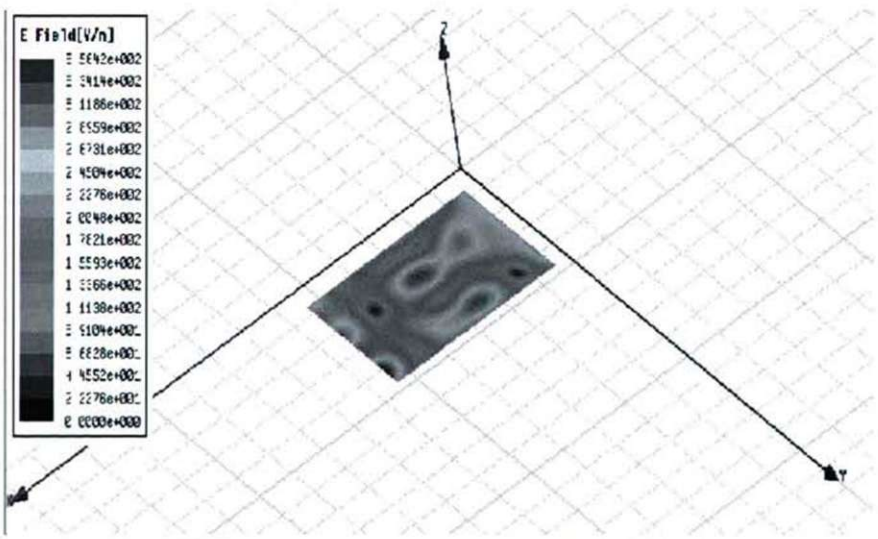

Figure 2. Electric Field Distribution Through the Dielectric

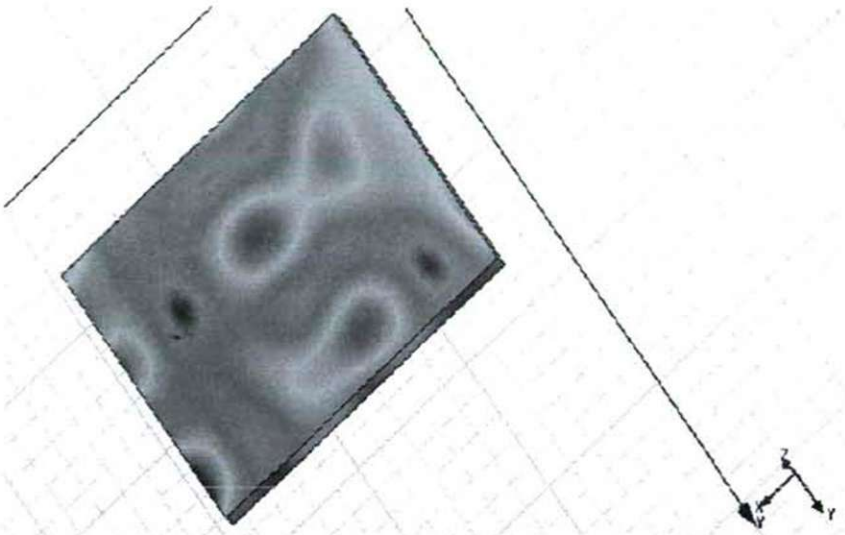

Figure3. Electric Field Distribution Through the Dielectric

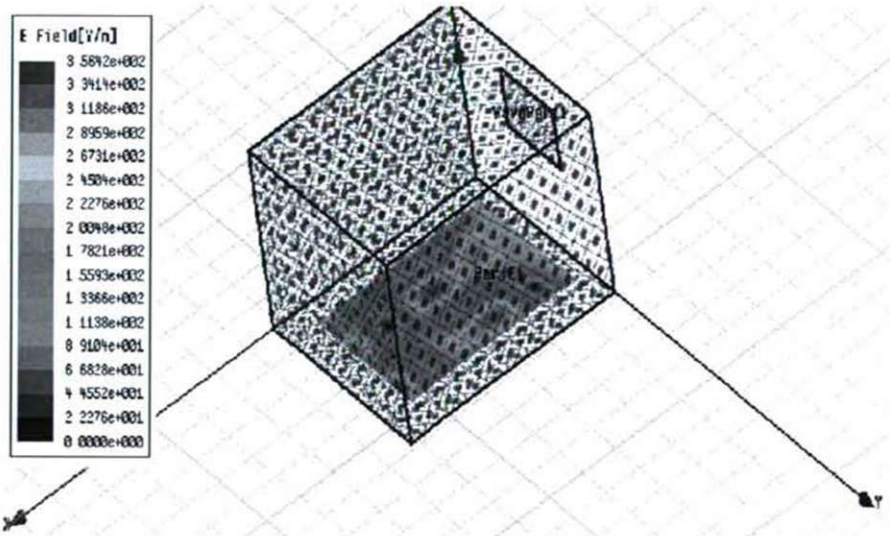

Figure 4. Electric Field Distribution Through the Dielectric . Boundary Conditions and the Position of the Waveport

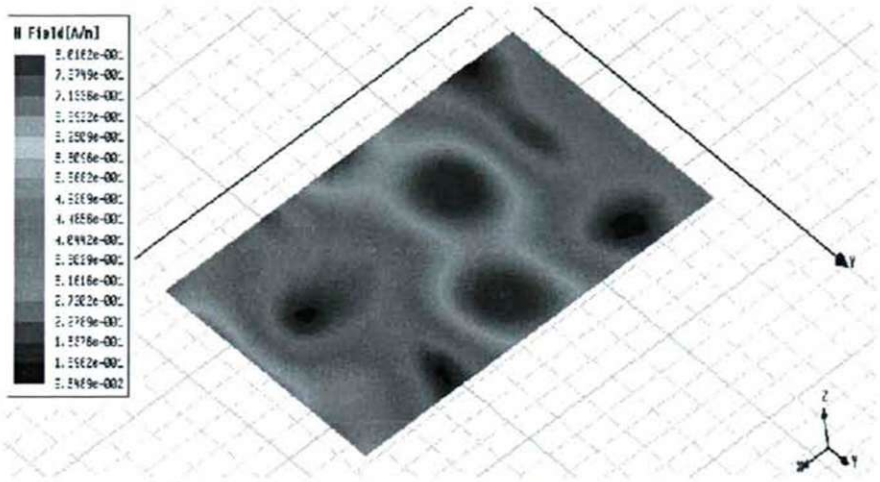

Figure 5. Magnetic Field Distribution Through the Dielectric

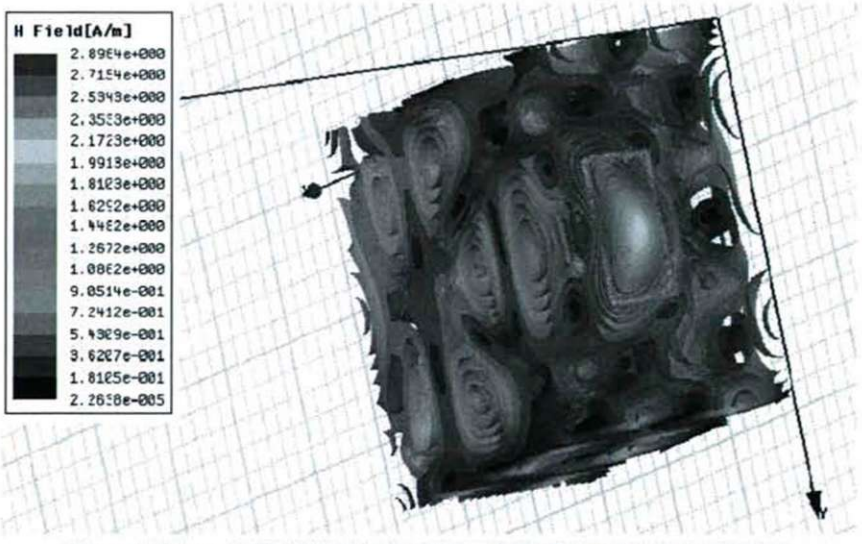

Figure 6. Magnetic Field Distribution Through the Waveguide and Dielectric

ACKNOWLEDGEMENTS

This work was partially supported by the strategic grant POSDRU/88/1.5/S/50783, Project ID50783 (2009), co-financed by the European Social Fund – Investing in People, within the Sectoral Operational Programme Human Resources Development 2007-2013.

4. CONCLUSIONS

Treating and drying using microwaves represents a technology that offers the material processor a new, powerfull and completely different tool with which it can be processed materials that can't be treated using conventional methods or which can improve the characteristic performances of materials.

From the analyze of numerical results it is wanted a homogenization of the electromagnetic field and implicitly of the thermal field wishing the elimination of the rotary plane and the possibility of using big dimensions of the recipients so that heating would be more uniform and efficient.

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BIOLOGICAL TREATMENT OF DIFFERENT FOOD INDUSTRIAL WASTEWATER BY *Xanthomonas campestris*

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ABSTRACT

Biological wastewater treatment is certainly one of the most important biotechnological processes, which have been used for over a century to treat municipal and industrial wastewaters. Industrial wastewater causes large-scale environmental problems mainly because of its extremely high organic content. Xanthan biosynthesis is usually performed on substrates containing different carbohydrates and nitrogen sources. These nutrients are often obtained from different raw materials that are intermediate or by-products of various food technologies. One of the greatest factors limiting the use of xanthan in large-scale fermentation processes is the cost of production when compared with similar polymers from algae or plants. The cost of feedstock used for polymer production is area where savings could be made in this respect. The present study examines xanthan production by *Xanthomonas campestris* under aerobic conditions on different food industrial wastewaters. Cultivation media were prepared to contain same amounts of carbon and nitrogen sources and all experiments were performed simultaneously, so that all stages of the biotechnological process would be carried out under identical conditions. In order to determine success of the performed biosynthesis, yield of xanthan and sugar conversion were determined. From this point of view, similar results were obtained. Also, different viscosities of cultivation media at the end of process were compared. Determined significant differences of viscosities and at the same time similar yield of xanthan suggest that biosynthesized polymers have different quality. High values of sugar and nitrogen conversions advocate that significant decrease of organic content in applied industrial wastewaters.

1. INTRODUCTION

Food and beverage industrial wastewater represents a large environmental pollutant. Industry in Vojvodina produces 80% of the total amount of wastewater, or 88% of organic pollution, expressed as COD, and within industry, the share of food industry is 31%, with the COD load as much as 82%, while the production of alcoholic beverages produce 2,9% of industrial wastewaters and 6,1% of the COD load. A significant part of food and beverage industrial wastewater pollution comes from high content of organic matter (1). A genetic characteristic of *Xanthomonas campestris* is xanthan biosynthesis when cultivated on media with an appropriate composition. In terms of carbon source, the mentioned producing microorganism is not too demanding. Glucose, sucrose and hydrolyzed starches are usually used as carbon sources and xanthan yield is affected by concentration of carbon source and carbon to nitrogen ratio. Xanthan gum has unique physical properties with number of industrial applications (food industries, cosmetics and petroleum industries) and may be used as stabilizer, emulsifier and thickening agent, lubricant, mobility control agent and inhibitor of crystallization. This polyanionic, hydrophilic biopolymer is a product of secondary metabolism (2). Among the microbial gums, xanthan occupies a prominent place in the market by having rheological properties that are quite different and unusual, such as a high degree of pseudoplasticity, a high viscosity even at low concentrations, stability and compatibility with most metallic salts, excellent solubility and stability in acidic and alkaline solutions and resistance to degradation at elevated temperatures and various pH levels (3).

Commercial production of xanthan gum uses glucose as the carbon substrate; consequently the price of xanthan production is high. For this reason, recent research in the field has particularly focused on the search for cheaper natural alternatives for the currently used substrates, namely glucose or sucrose, so as to control the cost of the production process as well as of the final product. One of the ways to decrease xanthan price, is using cheaper substrate like agricultural wastes (4).

Effluents from food processing industries are significant environmental pollutants and it is necessary to purify them before discharging into recipients. This process is often expensive and therefore the final product price increases. The aim of this study is to examine possibility of biological purification of food and beverage industrial wastewaters, from several different factories on the territory of Vojvodina, through conversion of organic compounds by microorganism *Xanthomonas campestris*, obtaining high value product – xanthan, simultaneously.

2. EXPERIMENTAL

2.1. Production microorganism

As a producing microorganism the strain of *Xanthomonas campestris,* labeled as A-1, was used for all experiments. This strain is a reisolate of a referent culture *Xanthomonas campestris* ATCC 13951.

2.2. Cultivation media

The cultivation media for the production of xanthan was wastewater from six different food and beverage proceeding factories: wastewater from oil industry (marked as OW), wastewater from brewery (marked as BW), alcohol industry wastewater (marked as AW), dairy industry wastewater (marked as DW), confectionery industry wastewater (marked as CW), mill industry wastewater (marked as MW), mill industry wastewater with the addition of enzyme-hydrolyzed starch (marked as MHW). Also, eight cultivation media was synthetic media containing glucose (marked as GCM), were used as control. These wastewaters were first analyzed to determine initial content of carbon and nitrogen. On the basis of obtained results all cultivation medias were enriched by addition of appropriate sugar (glucose for OW, AW, CW and GCM; maltose for BW; lactose for DW and starch for MW and MHW), so that the quantity of carbon source in medias is 1,5%. As a nitrogen source, yeast extract and $(NH_4)_2SO_4$ (in 2:1 ratio) were added, so that total nitrogen content is 0,02%. Each cultivation media was enriched with mineral salts in a quantity of 0,05% $MgSO_4 \cdot 7H_2O$ and 0,25 % K_2HPO_4. The pH value of the cultivation media was then set to 7,0 and sterilized in an autoclave at 121°C and overpressure of 1,1 bar during 20 minutes.

2.3. Cultivation

Inoculum was prepared in two steps, first, by refreshing the culture by incubation for 24h at 28°C and second, by double passage of microorganism on the synthetic media (marked as GCM) for 36h, at 28°C. Samples were spontaneously aerated and externally mixed (laboratory shaker, 150 rpm). The inoculation was performed by adding 10% of prepared inoculums. The biotechnological process of xanthan production was carried out under same experimental conditions in Woulff bottles, each containing 1,500 mL of the cultivation medium for biosynthesis with the appropriate composition (OW, BW, AW, DW, CW, MW, MHW and GCM). Cultivation was carried out under aerobic conditions (with air which was

conditioned in terms of moisture content and temperature, at a flow rate of 0.01 L/L·min in the first 48 h, and after that 0.02 L/L·min) and with external mixing at conditions mentioned above.In the first 48 h, the cultivation temperature was 28°C, after which it was increased to 30°C. The total time of cultivation was 120h. This regulation of process parameters was done according to the literature data (5). From the moment of inoculation, every 24 h, samples were taken for the analysis.

2.4. Product separation

After 120 h, biosynthesis was stopped and the cultivation broth was centrifuged at 10.000·G for 10 minutes (Eppendorf Centrifuge 5804) and the supernatant was cooled in an ice bath. While in the ice bath, ethanol (minimum 96%) was added in small portions (1 drop per second) till the content of 60% while constantly being mixed with a laboratory stirrer (UM-15, Tehtnica, Železniki). A saturated solution of KCl was added when half of the needed ethanol amount was poured into the cooled supernatant, in a quantity to reach a final content of 1%. The temperature of the mixture did not exceed 15°C. Afterward precipitation, with the aim of dehydration of the precipitated xanthan, the mixture was kept at 4°C for 24h. The final step of xanthan separation was carried out by centrifuging the mixture (3500 rpm for 15 minutes) on a laboratory centrifuge (LC-320, Tehtnica, Železniki). The precipitate was dried to constant mass on 60°C. This information was used to calculate the xanthan yield.

2.5. Analitical methods

The course of biosynthesis was monitored, every 24 h, by analyzing the samples taken from the cultivation broth. Depending on the analytical method, the sample was or was not processed before measuring. The separation of the solid from the liquid phase in the cultivation broth was carried out by centrifuging it at 10.000·G for 10 minutes (Eppendorf Centrifuge 5804). The reducing sugars content was monitored indirectly based on the glucose content in the supernatant of the cultivation broth by the method according to Miller (6). Total nitrogen content, in the cultivation broth supernatant, was determined by the Kjeldahl method (7). Rheological properties of cultivation broth samples were determined using rotational viscometer (REOTEST 2 VEB MLV Prüfgeräte-Verk, Mendingen, SitzFreitel) with double gap coaxial cylinder sensor system, spindle N. Volume of samples was 10ml. Based on deflection of measuring instrument, α (Skt) and using the equation: $\tau=0,1\cdot z\cdot\alpha$, shear stress, τ (Pa) was calculated, under defined values of shear rates. Value of constant z (dyn/cm^2·Skt) is 3,08. According to Ostwald de Vaele equation, which describes viscosity of pseudoplastic fluids, and calculated values of shear stress, rheological parameters were calculated.

3. RESULTS AND DISCUSSION

Eight cultivation media with enriched food industrial wastewater, from different food processing industries, were examined for xanthan productivity, quality of produced biopolymer and nitrogen and sugar conversion.

3.1. Xanthan yield and sugar conversion

According to the plan of experiment, xanthan was precipitated in order to determine the success of the performed biosynthesis in terms of xanthan yield and sugar conversion. The results of gravimetrical measurement are presented in Table 1. Based on the results in Table

1, the highest yield of xanthan was obtained on the wastewater from brewery (15,56 g/L) initially containing 15,97g/L of maltose. High yield was also achieved in wastewaters, enriched with glucose, from oil (14,18 g/L), confectionery (10,92 g/L) and alcohol industry (8,27 g/L). In these mediums the sugar conversion values were high as well as conversion of sugar into final product. In case of OW, conversion was 104,04% and explanation for this may be that applied strain of *X. campestris* used some components of medium that were not reducing sugars, for biosynthesis of xanthan. This corresponds with results obtained from the literature, that high degree of conversion (90%), calculated on digestible sugars, is achieved when sugar concentration in media is less than 2% (8).

Table 1. Xanthan yield and sugar conversion in enriched food industrial wastewaters after 120 h of xanthan biosynthesis

Medium	Content of reducing sugars[g/L]		Sugar conversion(3) [%]	Xanthan yield [g/L]	Conversion(4) [%]
	S_0(1)	S(2)			
BW	15,97	2,08	86,98	15,56	97,43
OW	13,63	0,36	97,36	14,18	104,04
CW	14,29	0,68	95,24	10,92	76,42
AW	12,49	0,16	98,72	8,27	66,21
DW	14,29	13,46	5,81	0	0
MHW	13,77	3,97	71,17	5,78	41,98
GCM	15,27	2,58	83,10	7,52	49,25

(1) sugar content in the inoculated media
(2) sugar content after 120 h of cultivation
(3) sugar conversion [%] = $(S_0-S)/S_0 \cdot 100$
(4) conversion [%] = $P/S_0 \cdot 100$

On the wastewater from dairy industry biosynthesis of xanthan did not occur. Based on that result it can be concluded that applied strain of *X. campestris* is not able to grow and produce xanthan in a medium containing lactose as carbon source. Results obtained in this work are similar to literature data, where for initial amount of carbon source of 2%, yields of xanthan for sucrose, maltose and lactose were 13,234g/L, 12,321g/L and 1,008g/L, respectively (9). In wastewater from mill industry, 15g/L of starch were added and yield of xanthan was 5,45g/L with the conversion of 36,33%. Conversion of sugar could not be calculated because applied analytical method (6) is suitable only for reducing sugars.

Yield of xanthan on wastewater from mill industry enriched with enzyme-hydrolyzed starch is 5,78 g/L, sugar conversion is 71,17 % and 41,98 % of sugar was converted into product. According to similar results obtained for MW and MHW, applied strain of *X. campestris* has amylolitic activity. Yield of synthetic cultivation media containing glucose (7,52 g/L) is notably lower then glucose enriched wastewaters (OW, CW and AW). The explanation for that could be that wastewaters contain some unidentified substances that microorganism used as sources of carbon for growth and production of xanthan.

Nitrogen conversion value (data not shown) in OW, AW, BW and CW medias, could not be accurately determined, because applied separation technique is not appropriate for such viscous cultivation broths. During the first 48h of cultivation, decrease of nitrogen content was significant, but increasing viscosity of cultivation broths prevented further measurements. Value of nitrogen conversion in GCM was 70%, and in MW, MHW and DW were between 40% and 50%.

3.2. Rheological behavior of cultivation broth

Flow curves, relationship between shear rate and shear stress, of all but DW cultivation broth after 120h of biosynthesis, shown in Figure 1, represent pseudoplastic type of flow. That is also confirmed by values of flow behavior index and coefficient of correlation presented in Table 2.

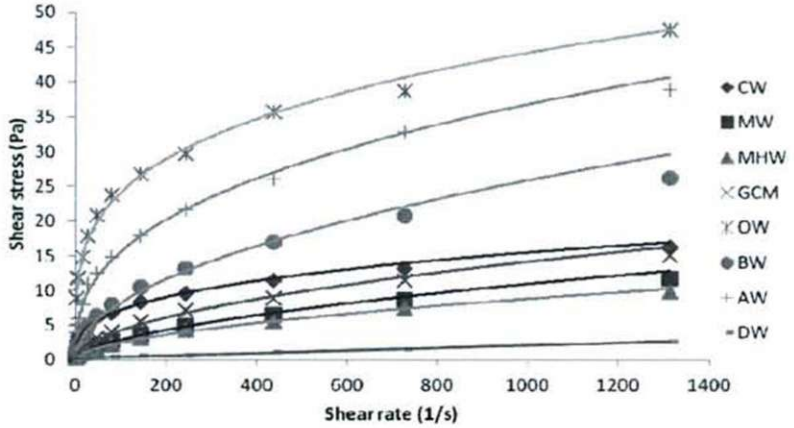

Figure 1. Shear stress as a function of shear rate in cultivation broths after 120 h of biosynthesis

Given that the viscosity and consistency factor are proportional, values of consistency factor (Table 2) indicate different quality and quantity of synthesized biopolymer. Values of flow behavior index, high values of consistency factor as well as results of xanthan yield point that glucose enriched (OW, AW and CW) and maltose enriched (BW) mediums contained high amount of xanthan with the good quality. According to the literature data (9), yield of xanthan in wastewaters enriched with starch (MW and MHW) and in glucose synthetic media, was significantly lower than expected and obtained rheological parameters indicate that biosynthesized xanthan have lower quality. Based on rheological parameters as well as the value of yield, on wastewater containing lactose, biosynthesis of xanthan has not occurred.

Table 2. Rheological parameters and coefficient of correlation for cultivation broths after 120 h of biosynthesis

Media	*K*	*n*	R^2
OW	*7,1274*	*0,2641*	*0,99*
AW	*2,7847*	*0,3735*	*0,99*
CW	*1,5373*	*0,334*	*0,99*
BW	*0,8358*	*0,4967*	*0,99*
GCM	*0,3789*	*0,5235*	*0,99*
MW	*0,1968*	*0,5815*	*0,99*
MHW	*0,1954*	*0,5509*	*0,99*
DW	/	/	/

4. CONCLUSION

Production of xanthan on different, enriched wastewaters was examined in this study. From the obtained results it can be seen that the highest yield was obtained from the maltose enriched wastewater (15,56g/L) followed by glucose enriched wastewaters (14,18g/L for OW,

10,92g/L for CW and 8,27g/L for AW). These yields are much higher comparing to yield of xanthan on glucose synthetic media (7,52g/L). Also the significant decrease of sugar content is obtained in cultivation medias containing glucose (98,72% for AW, 97,36% for OW, 95,24% for CW and 83,10% for GCM) and maltose (86,98%). Applied strain of *Xanthomonas campestris* do not have the ability to synthesize xanthan from lactose but it have amylolitical activity which can be seen according to similar yields of cultivation mediums containing starch (5,45g/L) and hydrolyzed starch (5,78g/L). Based on these results, enzyme hydrolysis of starch under these experimental conditions is not justified. This suggests the further optimization of the wastewaters containing starch under applied experimental conditions.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the support of the Ministry of Education and Science, Republic of Serbia, project number: TR-31002.

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COMPUTER PROGRAM BASED ON FINITE ELEMENT METHOD FOR STATIC ANALYSIS OF PLANAR STRUCTURES OF ARTICULATED WOODEN BARS

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ABSTRACT

Today modern design must meet several requirements related in particular to be determined by the precision of solutions for various types of structures.
A major task is to determine the behavior of mechanical structures or structural elements in effect of external actions. By applying the finite element method, physical systems governed by partial differential equations with having an infinite number of degrees of freedom are reduced to discrete physical systems with a finite number of degrees of freedom governed by algebraic equations.

Specifically, the essential question is: what is the answer structure when subjected to external actions (variations of strength, temperature, etc.).

Program designed by the authors using the finite element tool engineer put in hand work necessary to optimize the design, with positive effects on the complete analysis of stress and tensions in planar structures of articulated bars.

1. INTRODUCTION

In this paper, program designed using finite element calculation was adopted by the authors following simplifying assumption: the flat structure of articulated bars made of wood will not take into account material anisotropy, considering that by its geometry and external forces acting on the nodes of the structure, the structure is similar to the response of isotropic materials.

By adopting this hypothesis, computer program developed by the authors can be adapted to any type of material used to make the structure. It is only necessary to replace in the program only the geometric, the physico-mechanical and material characteristics [6], [7], [8]..

2. MATERIALS AND METHODS

This type of wooden structures studied and presented in the paper is requested to stretching and compression. Structure is composed of bars whit 2 nodes and 2 degrees of freedom on each node. The two degrees of freedom per node are the horizontally and vertically displacements [3], [9], [10]. It aims to determine the nodals elastic equilibrium equations using the displacements method [4], [11], [14], [15]. The analysis requires two reference systems one local that is attached to each element of the bar and a global for the analysis of the entire structure of bars.

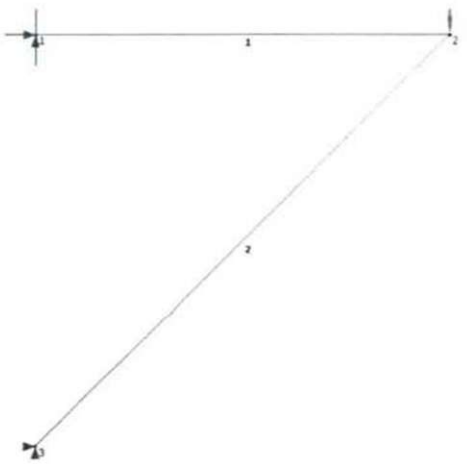

Figure 1.

It presents the structure calculation algorithm, which is based program developed by the authors.

By removing a bar element node structure and introduction of nodal forces expressed in the local reference system to obtain bar elongation or shortening (1).

$$\Delta l = \frac{f_i \cdot l}{E \cdot A}. \tag{1}$$

Where:

f_i – nodal force in "i" node.

l – length of the bar

$E \cdot A$ – tensile and compressive stiffness of the bar.

Length of each bar (2) is determinate with the relation

$$l(i) = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2} \tag{2}$$

Nodal forces acting on nodes at the ends of each element (3), (4), are equal and opposite [12], [13].

Matrix of nodal forces (5) in local reference system is

$$f_i = \frac{E \cdot A}{l}(u_i - u_j), \tag{3}$$

$$f_j = \frac{E \cdot A}{l}(u_j - u_i), \tag{4}$$

$$\{f\} = \begin{Bmatrix} f_i \\ f_j \end{Bmatrix} = \frac{EA}{l}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}\begin{Bmatrix} u_i \\ u_j \end{Bmatrix} = [k]\cdot\{d\}.$$

(5)

In the global reference system, each node bar element has a horizontal and vertical displacement [3], [7], [8]. Designing nodal displacements in local reference system in the direction bar elements obtaining the expressions of them depending on global displacements (10).

$$u_i = U_i \cdot \cos\alpha + V_i \cdot \sin\alpha, \tag{6}$$

$$u_j = U_j \cdot \cos\alpha + V_j \cdot \sin\alpha, \tag{7}$$

$$l = \cos\alpha, \tag{8}$$

$$m = \sin\alpha, \tag{9}$$

$$\{d\}=\begin{Bmatrix} u_i \\ u_j \end{Bmatrix}=\begin{bmatrix} l & m & 0 & 0 \\ 0 & 0 & l & m \end{bmatrix}\begin{Bmatrix} U_i \\ V_i \\ U_j \\ V_j \end{Bmatrix}=[k]\cdot\{D\}. \tag{10}$$

Where:

$\{d\}$ – nodal displacements vector in local system;

$L=\begin{bmatrix} l & m & 0 & 0 \\ 0 & 0 & l & m \end{bmatrix}$ – directors cosine vectors of element;

$\{D\}$ – nodal displacements vector in global system;

$[k]$ – stiffness matrix of element.

The vectors of nodal forces in local system (11) expressed according to nodal forces in global reference system is

$$\{f\}=\begin{Bmatrix} f_i \\ f_j \end{Bmatrix}=\begin{bmatrix} l & m & 0 & 0 \\ 0 & 0 & l & m \end{bmatrix}\begin{Bmatrix} F_{xi} \\ F_{yi} \\ F_{xj} \\ F_{yj} \end{Bmatrix}. \tag{11}$$

Given the relationships shown are obtained elastic nodal equation in local system (12) and global system (13).

$$\{f\}=[k]\cdot\{d\}; \tag{12}$$

$$\{F\}=[L]^T\cdot[k]\cdot[L]\cdot\{d\}. \tag{13}$$

Where:

$[K]=[L]^T\cdot[k]\cdot[L]$ – element stiffness matrix [8], [11] in global reference system (14).

$$[K]=[L]^T\cdot[k]\cdot[L]=\begin{bmatrix} l & 0 \\ m & 0 \\ 0 & l \\ 0 & m \end{bmatrix}\frac{EA}{l}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}\begin{bmatrix} l & m & 0 & 0 \\ 0 & 0 & l & m \end{bmatrix}. \tag{14}$$

Elastic nodal equation in local system and global system [9], [12], becomes (15), (16)

$$\begin{Bmatrix} F_{xi} \\ F_{yi} \\ F_{xj} \\ F_{yj} \end{Bmatrix}=\frac{EA}{l}\cdot\begin{bmatrix} l^2 & lm & -l^2 & -lm \\ ml & m^2 & -ml & -m^2 \\ -l^2 & -lm & l^2 & lm \\ -ml & -m^2 & ml & m^2 \end{bmatrix}\begin{Bmatrix} U_i \\ V_i \\ U_j \\ V_j \end{Bmatrix}, \tag{15}$$

$$\{F\}=[K]\{D\}. \tag{16}$$

By assembling the stiffness matrices of elements obtaining the stiffness matrix of the entire structure.

Solving the system of nodal equations of equilibrium [11] leads to the determination of nodal displacements (17).

$$\{D\}=[K]^{-1}\{F\}. \tag{17}$$

Calculation of tensile or compressive effort [1], [2], [5], of each bar element ("i") is determined by the relationship (18)

$$N(i) = \frac{EA}{l} \cdot \Delta l . \tag{18}$$

Normal tension for each element [2], [5] is determined using the relationship (19)

$$\sigma_x(i) = \frac{N(i)}{A} . \tag{19}$$

Calculation algorithm presented is theoretical support necessary to design computer program using finite element method.

Initial data structure considered are the following:

$F = 1000\,[N]$;

Young's modulus $E = 0{,}12 \cdot 10^6 [N/mm^2]$(Mpa);

$A = 100[mm^2]$;

```
clear;clc;clf;
%Cartesian coordinates of the nodes expressed in [mm]
noduri=[ 0    0
         300  0
         0   -300]
%Finite element matrix (including the Young's modulus and cross section areas in[mm^2])
    node  node Young's modulus   areas section
elem=[ 1    2        200000          100
       2    3        200000          100]
% Forces applied to the beam
      %node   fx     fy
forte=[ 2       0  -1000]
% Boundary conditions applied
     % node bx  by
cond=[   1     1     1
         3     1     1   ]
%Number of nodes structure
nnd=length(noduri(:,2))
% Number of elements structure
nel=length(elem(:,4))
% Determine the number of forces and boundary conditions applied to the structure
nnf=length(forte(:,1))
ncond=length(cond(:,1))
%Vector of nodal coordinates on x and y axis
cx=noduri(:,1)
cy=noduri(:,2)
%Number of degrees of freedom per node (ngn),element (nel) and the total number of degrees
of freedom (nec)
ngn=2
ngel=2*ngn
nec=nnd*ngn
% Initialization to zero for MR (stiffness matrix), F (Vector of nodal forces) and index
MR=zeros(nec,nec)
F=zeros(nec)
index=zeros(2*ngn)
for i=1:nel
nod1=elem(i,1)
```

```
nod2=elem(i,2)
E=elem(i,3)
A=elem(i,4)
% Length of beam finite elements and the value of matrix stiffness
le=sqrt((cx(nod2)-cx(nod1))^2+(cy(nod2)-cy(nod1))^2)
ka=E*A/le
% Cosines directors of each beam elements.
c=(cx(nod2)-cx(nod1))/le
s=(cy(nod2)-cy(nod1))/le
length(i)=le'
% Vectors cosine directors of each beam elements
vc(i)=c
vs(i)=s
%Position of the element stiffness matrix terms in the global stiffness matrix.
index(1)=ngn*nod1-1
index(2)=ngn*nod1
index(3)=ngn*nod2-1
index(4)=ngn*nod2
% Element stiffness matrix of the horizontal bar.
mrelp=[ c*c  c*s
        c*s  s*s]
% Element stiffness matrix inclined at an angle bar.
mrel=ka*[  mrelp  -mrelp
          -mrelp   mrelp]
% Assembling the stiffness matrix of each element in the global stiffness matrix.
for i1=1:ngel
j1=index(i1)
for i2=1:ngel
j2=index(i2)
MR(j1,j2)=MR(j1,j2)+mrel(i1,i2)
end
end
end
% Addition of concentrated forces on the structure.
for i=1:nnf
n=forte(i,1)  % forces acting node
if forte(i,2)~=0
% Force on the x direction in the global reference system
f=forte(i,2)
F(ngn*(n-1)+1)=F(ngn*(n-1)+1)+f
end
if forte(i,3)~=0
% Force on the y direction in the global reference system
f=forte(i,3)
F(ngn*(n-1)+2)=F(ngn*(n-1)+2)+f
end
end
% Applying boundary conditions.
for i=1:ncond
n=cond(i,1)  % node where displacement is zero.
```

```
% Displacement zero on the x axes in the global reference system.
if cond(i,2)==1
MR(ngn*(n-1)+1,:)=zeros(1,nec)
MR(:,ngn*(n-1)+1)=zeros(nec,1)
MR(ngn*(n-1)+1,ngn*(n-1)+1)=1
F(ngn*(n-1)+1)=0
end
% Displacement zero on the y axes in the global reference system.
if cond(i,3)==1
MR(ngn*(n-1)+2,:)=zeros(1,nec)
MR(:,ngn*(n-1)+2)=zeros(nec,1)
MR(ngn*(n-1)+2,ngn*(n-1)+2)=1
F(ngn*(n-1)+2)=0
end
end
% Calculation of nodal displacements
depl=MR\F
for i=1:nnd
u(i)=depl(ngn*(i-1)+1)
v(i)=depl(ngn*(i-1)+2)
end
% Display unknowns displacements.
fprintf('nodul u(mm) v(mm)\n')
for i=1:nnd
fprintf('%3.f %3.9f %3.9f\n',i,u(i),v(i))
end
fprintf('\n')
% Determination of normal stress and sectional efforts
for i=1:nel
nod1=elem(i,1)
nod2=elem(i,2)
E=elem(i,3)
A=elem(i,4)
% Length of each bar element
le=sqrt((cx(nod2)-cx(nod1))^2+(cy(nod2)-cy(nod1))^2)
% Cosines directors of each beam elements.
c=(cx(nod2)-cx(nod1))/le
s=(cy(nod2)-cy(nod1))/le
% dn1 and dn2, vectors of nodal displacements at the ends of the bar element
dn1=[u(nod1) v(nod1)]
dn2=[u(nod2) v(nod2)]
% Tensile and compressive stiffness and directors cosine vector vd
ka=E*A/le
vd=[c s]
% Elongation or shortening expressed as the difference between nodal displacements of % the
bar in the local reference system of finite element
dl=dot(dn2,vd)-dot(dn1,vd)
% Displacements of "nod2" in local reference system is dot (dn2, vd) (projection of NOD2
global displacement in the direction bar).
% Displacements of "nod1" in local reference system is dot1 (dn1, vd) (global displacement
```

projection on the direction nod1 bar), dot represents the scalar product.
% Determination of tensile or compression sectional effort and tensions tx for each bar "i" of the structure.

```
N(i)=ka*dl
tx(i)=N(i)/A
end
```

% Display unknowns represented by sectional efforts

```
fprintf('elementul  efortul sectional Fx(N)\n')
for i=1:nel
fprintf(' %3.f %6.2f\n',i,N(i))
end
fprintf('\n')
```

% Display unknowns tensions

```
fprintf('elementul tensiune tx(MPa)\n')
for i=1:nel
fprintf(' %3.f %3.2f\n',i,tx(i))
end
```

3. CONCLUSIONS

Some of the data obtained by running the program: stiffness of bars, length of bars, sectional effort and normal stresses in each bar is shown below:

length (element 1) = 300.0000
length (element 2) = 424.2641
ka = 40000
ka =2.8284e+004
node1 node 2 node 3
u = 0 0.0250 0
v = 0 -0.0957 0
node u(mm) v(mm)
1 0.000000000 0.000000000
2 0.025000000 -0.095710678
3 0.000000000 0.000000000
N1=1.0e+003 *1.0000 -1.4142
N2=1.0e+003 *(-1.4142)
tx(1) = 10.0000
tx(2) =-14.1421
element sectional effort
1 1000.00
2 -1414.21
element normal stress tx(MPa)
1 10.00
2 -14.14

Numerical method has the advantage that the computer program developed by the author, leads to solutions of the problem that converge to the "exact" solution. The paper presented, is a novelty in terms of adapting to a full calculation of structures regardless of physical-mechanical properties of materials they are made.

The main steps that were followed in this program by the author are:
-stiffness matrices-writing of the elements composing the structure of the structure;
-calculation of the cosine directors and transformation matrices;
-matrix assembly of each beam in the global stiffness matrix of the structure;
-establishment of nodal forces for the entire structure;
-application related conditions;
-determining the nodal equilibrium equations system;
-determining the efforts and the tension at each beam ends.

Analytical solving of any type of structure with geometric and physical-mechanical characteristics specific require more time and precision of results is not so great.

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STATIC ANALYSIS OF CONTINUOUS BEAM WITH NUMERICAL METHOD (FEM)

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ABSTRACT

Finite element method is a method of analysis and simulation of current real phenomena. This paper focuses on this method, applied through finite element analysis program Matlab, presenting a structural analysis application useful in the field of forest, mechanical and structural engineering.

Program designed by the authors using the finite element tool engineer put in hand work necessary to optimize the design, with positive effects on the complete analysis of stress and tensions in continuous beams.

1. INTRODUCTION

In the finite-element method, a distributed physical system to be analysed is divided into a number (often large) of discrete elements. The division into elements may partly correspond to natural subdivisions of the structure. Most or all of the model parameters have very direct relationships to the structure and material properties of the system [6], [7] [8].

2. MATERIALS AND METHODS

This paper presents the calculation of flat structures with rigid nodes using finite element method. In this case there are no inertial or damping effects, or at least they are negligible [3], [9], [10]. Flat structure is modeled as a simple continuous beam with simply supports and 1 articulated support located at the left end of the structure

This type of structure is composed of bars whit 2 nodes and 3 degrees of freedom on each node [1], [2] [6], [7].The three degrees of freedom per node are the horizontally and vertically displacements and also the rotated section. It aims to determine the nodals elastic equilibrium equations using the displacements method [4], [11], [14], [15]. The analysis requires two reference systems [12], [13], one local that is attached to each element of the bar and a global for the analysis of the entire structure of bars.

3. RESULTS AND DISCUSSION

Generalized displacement and generalized forces vectors (1) of a beam element are [3], [5], [8]:

$$\{d\} = \{u_i, v_i, \varphi_i, u_j, v_j, \varphi_j\}^T, \qquad (1)$$
$$\{f\} = \{N_i, T_i, M_i, N_j, T_j, M_j\}$$

Stiffness matrix elements are determined by applying displacements on each degree of freedom and blocking the corresponding the other remaining degrees of freedom.

At each applied displacement nodes produce at the ends of bar sectional efforts on the 6 degrees of freedom [9], [12]. By applying the 6 successive displacements and using the principle of superposition, determine the relationship between generalized displacement and generalized forces vector [4], [9]. Stiffness matrix contains terms that depend on the geometry of the beam and physical-mechanical properties of the material.

$$[k]=\begin{bmatrix} EA/l & 0 & 0 & -EA/l & 0 & 0 \\ 0 & 12EI_z/l^3 & 6EI_z/l^2 & 0 & -12EI_z/l^3 & 6EI_z/l^2 \\ 0 & 6EI_z/l^2 & 4EI_z/l & 0 & -6EI_z/l^2 & 2EI_z/l \\ -EA/l & 0 & 0 & EA/l & 0 & 0 \\ 0 & -12EI_z/l^3 & -6EI_z/l^2 & 0 & 12EI_z/l^3 & -6EI_z/l^2 \\ 0 & 6EI_z/l^2 & 2EI_z/l & 0 & -6EI_z/l^2 & 4EI_z/l \end{bmatrix} \quad (2)$$

Orthogonal matrix (4) that connects the components of a vector in global and local reference system is a transformation matrix and is of the form [8], [11]:

$$[K]=[T]^T\cdot[k]\cdot[T] \quad (3)$$

Where: $[K]$- stiffness matrix, in global reference system.;$[k]$-_stiffness matrix, in local reference system;$[T]$- transformation matrix.

$$[T]=\begin{bmatrix} \cos\alpha & \sin\alpha & 0 & 0 & 0 & 0 \\ -\sin\alpha & \cos\alpha & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \cos\alpha & \sin\alpha \\ 0 & 0 & 0 & 0 & -\sin\alpha & \cos\alpha \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad (4)$$

The displacement and efforts at the ends of bars is determinate by applying conditions and solving the system equations of the nodal equilibrium. By applying the superposition principle [], [2],[4], we determined the relation between the sectional efforts to ends beam, when were applied nodal displacements (u,v,φ) in each node on the 3degrees of freedom. This is the equilibrum equation of beam elements in the local reference system.

Initial data of beam studies are: force is applied to the beam in node 8 having the coordinates $x=2000[mm], y=0[mm]$; Section height is $h=100[mm]$; Young's modulus $E=2.1\cdot10^5[N/mm^2]$; Transverse modulus of the material $E=8\cdot10^4[N/mm^2]$;Tensile-compressive stiffness of the structure $E\cdot A=100^2$; Bending stiffness of the structure. $E\cdot I_z=100^4/12$, $F_y=10^3[N]$.

The numerical program.

```
% Continuous beam is considered. Required to determine the nodal displacements, stresses
and sectional efforts at the ends of bars.
clear; clc;
%Cartesian coordinates of the nodes expressed in [mm]
%            x     y
nodes= [0   0
        200 0
        400 0
        600 0
        800 0
       1000 0
       1200 0
       1400 0
       1600 0
       1800 0
       2000 0]
% Finite element matrix
% elem nod1 nod2  h(section height)
elem=[ 1   2   100
       2   3   100
       3   4   100
```

```
        4   5   100
        5   6   100
        6   7   100
        7   8   100
        8   9   100
        9  10   100
       10  11   100]
% Young's modulus [N/mm^2]
E=2.1*10^5
% Transverse modulus of the material [N/mm^2]
G=8*10^4
% Tensile-compressive and bending stiffness of the structure.
ea=100^2
eiz=100^4/12
%Number of nodes of the structure
nnd=length(noduri(:,2))
% Number of elements of structure
nel=length(elem(:,2))
% Forces applied to the beam
%     node fx   fy   momz
forte=[  8   0  -1000    0]
% Boundary conditions applied to the beam
%    node bx by  brz
cond=[ 1   1   1   0
       3   0   1   0
       5   0   1   0
       7   0   1   0
       9   0   1   0
      11   0   1   0]
% Determine the number of forces and boundary conditions applied to the structure
nnf=length(forte(:,1))
ncond=length(cond(:,2))
% Axes x and y coordinates of the node structure
cx=noduri(:,1)
cy=noduri(:,2)
%Number of degrees of freedom per node (ngn),element (nel) and the total number of degrees
of freedom (nec)
ngn=3
ngel=2*ngn
nec=nnd*ngn
% Initialization to zero for MR, F and index
MR=zeros(nec,nec)
F=zeros(nec)
index=zeros(2*ngn)
% The calculation of the beam with rigid nodes
for i=1:nel
nod1=elem(i,1)
nod2=elem(i,2)
h(i)=elem(i,3)
for ii=1:ngn
```

```
index(ii)=ngn*(nod1-1)+ii
end
for iii=ngn+1:2*ngn
index(iii)=ngn*(nod2-2)+iii
end
% Length of beam finite elements
le=sqrt((cx(nod2)-cx(nod1))^2+(cy(nod2)-cy(nod1))^2)
% Cosines directors of beam elements.
c=(cx(nod2)-cx(nod1))/le
s=(cy(nod2)-cy(nod1))/le
length(i)=le'
% Vectors cosine directors
vc(i)=c
vs(i)=s
% Matrix elements stiffness
e1=ea/le
e2=12*eiz/le^3
e3=6*eiz/le^2
e4=4*eiz/le
e5=2*eiz/le
mrel=[e1  0   0  e1  0    0
       0  e2  e3  0 -e2  e3
       0  e3  e4  0 -e3  e5
      -e1  0   0  e1  0   0
       0 -e2 -e3  0  e2 -e3
       0  e3  e5  0 -e3  e4]
% Transformation matrix
c1=[c -s 0]'
c2=[s c 0]'
c3=[0 0 1]'
c0=[0 0 0]'
T=[c1 c2 c3 c0 c0 c0
   c0 c0 c0 c1 c2 c3]
% Stiffness matrix in global reference system
mrel=T'*mrel*T
% Assembling the stiffness matrices of elements
for i1=1:ngel
j1=index(i1)
for i2=1:ngel
j2=index(i2)
MR(j1,j2)=MR(j1,j2)+mrel(i1,i2)
end
end
end
% Set up vector of nodal loads
for i=1:nnf
%Forces  nodes
n=forte(i,1)
if forte(i,2)~=0
f=forte(i,2)
```

```
F(ngn*(n-1)+1)=F(ngn*(n-1)+1)+f
end
if forte(i,3)~=0
f=forte(i,3)
F(ngn*(n-1)+2)=F(ngn*(n-1)+2)+f
end
if forte(i,4)~=0
f=forte(i,4)
F(ngn*(n-1)+3)=F(ngn*(n-1)+3)+f
end
end
% Applying boundary conditions
for i=1:ncond
% Nodes with displacement zero
n=cond(i,1)
% Implementation of the conditions with zero displacement on  x direction
if cond(i,2)==1
MR(ngn*(n-1)+1,:)=zeros(1,nec)
MR(:,ngn*(n-1)+1)=zeros(nec,1)
MR(ngn*(n-1)+1,ngn*(n-1)+1)=1
F(ngn*(n-1)+1)=0
end
% Implementation of the conditions with zero displacement on  y direction
if cond(i,3)==1
MR(ngn*(n-1)+2,:)=zeros(1,nec)
MR(:,ngn*(n-1)+2)=zeros(nec,1)
MR(ngn*(n-1)+2,ngn*(n-1)+2)=1
F(ngn*(n-1)+2)=0
end
% Implementation of the conditions with zero rotations around  z axes
if cond(i,3)==1
MR(ngn*(n-1)+3,:)=zeros(1,nec)
MR(:,ngn*(n-1)+3)=zeros(nec,1)
MR(ngn*(n-1)+3,ngn*(n-1)+3)=1
F(ngn*(n-1)+3)=0
end
end
% Determination of initial unknowns represented by nodal displacements by solving the
system of elastic nodal equations
% Format long e
depl=MR\F
for i=1:nnd
u(i)=depl(ngn*(i-1)+1)
v(i)=depl(ngn*(i-1)+2)
rotz(i)=depl(ngn*(i-1)+3)
end
% Display the primary unknowns (nodal displacements)
fprintf('nod u(mm) v(mm) rotz(rad)\n')
for i=1:nnd
fprintf(' %2.f %2.5f %2.5f\n',i,u(i),v(i),rotz(i))
end
```

```
fprintf('\n')
pause
%Determination of strains and tensions in ends of each beam finite element
 for i=1:nel
% Redefining nodes
nod1=elem(i,1)
nod2=elem(i,2)
% Calculation of beam lengths of all finite elements
le=sqrt((cx(nod2)-cx(nod1))^2+(cy(nod2)-cy(nod1))^2)
% Determine the cosine directors of each beam finite element
c=(cx(nod2)-cx(nod1))/le
s=(cy(nod2)-cy(nod1))/le
% Determination of global displacement of each beam finite element
ue1=depl(elem(i,1)*ngn-2,1)
ue2=depl(elem(i,1)*ngn-1,1)
ue3=depl(elem(i,1)*ngn,1)
ue4=depl(elem(i,2)*ngn-2,1)
ue5=depl(elem(i,2)*ngn-1,1)
ue6=depl(elem(i,2)*ngn,1)
%Determination of nodal displacements for each beam finite element in local reference
system
ul1=c*ue1+s*ue2
ul2=(-s)*ue1+c*ue2
ul3=ue3
ul4=c*ue4+s*ue5
ul5=(-s)*ue4+c*ue5
ul6=ue6
% Calculation of stress from the first end of the beam
% Strain from tensile (compressive)
e11=(ul4-ul1)/le
% Strain from the bending deformation
e12=h(i)/(2*le^2)*(-6*ul2-4*ul3*le+6*ul5-2*ul6*le)
stress(1)=(e11-e12)*elem(i,3)
stress(2)=(e11+e12)*elem(i,3)
%The maximum stess to the first end of the beam
STRESS=max(abs([stress(1),stress(2)]))
% Calculation of stress at the second end of the beam
% Strain from tensile (compressive)
e21=(ul4-ul1)/le
% Strain from the bending deformation
e22=h(i)/(2*le^2)*(6*ul2+2*ul3*le-6*ul5+4*ul6*le)
stress(3)=(e21-e22)*elem(i,3)
stress(4)=(e21+e12)*elem(i,3)
% The  maximum stress to the first end of the beam STRESS2=max(abs([stress(3),stress(4)]))
%Maximum stress on each finite element beam
Stresselem=max(abs([STRESS1,STRESS2]))
tensmax(i)=Stresselem
% Display nodal unknowns tension and maximum stress on each beam finite elements
fprintf('\n')
fprintf('element  %2.f\n',i)
```

```
fprintf('node %2.f stressnod1 stressnod2 maxstressnode1 \n',elem(i,1))
fprintf(' %2.5f  %2.5f  %2.5f\n',stress(1),stress(2),STRESS1)
fprintf('node %2.f stressnod2 stressnod2   maxstressnode2 \n',elem(i,2))
fprintf(' %2.5f  %2.5f %2.5f\n',stress(3),stress(4),STRESS2)
fprintf('Maximum stress on element)
fprintf(' %2.5f \n', Stresselem)
end
  for i=1:nel
% Redefining nodes
nod1=elem(i,1)
nod2=elem(i,2)
% Calculation of beam lengths of all finite elements
le=sqrt((cx(nod2)-cx(nod1))^2+(cy(nod2)-cy(nod1))^2)
%Determine the cosine directors of each finite element
c=(cx(nod2)-cx(nod1))/le
s=(cy(nod2)-cy(nod1))/le
% Stiffness matrix of element
e1=ea/le
e2=12*eiz/le^3
e3=6*eiz/le^2
e4=4*eiz/le
e5=2*eiz/le
mrel=[e1  0   0  e1  0   0
       0  e2  e3  0  -e2  e3
       0  e3  e4  0  -e3  e5
      -e1  0   0  e1  0   0
       0 -e2 -e3  0   e2 -e3
       0  e3  e5  0  -e3  e4]
% Transformation matrix of elements
c1=[c -s 0]'
c2=[s c 0]'
c3=[0 0 1]'
c0=[0 0 0]'
T=[c1 c2 c3 c0 c0 c0
   c0 c0 c0 c1 c2 c3]
% Stiffness matrix in global reference system
mrel=T'*mrel*T
% The vector displacement for finite element beam
deplel=[u(nod1,v(nod1,rotz(nod1),u(nod2),v(nod2),rotz(nod2)]'
% Sectional efforts vector
ef=mrel*deplel
nx(1,i)=-ef(1) nx(2,i)=ef(4) ty(1,i)=-ef(2) ty(2,i)=ef(5) mz(1,i)=-ef(3) mz(2,i)=ef(6)
% Display the sectional efforts
fprintf('\n')
fprintf('elementul %2.f\n',i)
fprintf('nod %2.f Fx Fy Mz \n',elem(i,1))
fprintf(' %2.5f  %2.5f  %2.5f\n',ef(1),ef(2),ef(3))
fprintf('nod %2.f Fx Fy Mz \n',elem(i,2))
fprintf(' %2.5f  %2.5f  %2.5f\n',ef(4),ef(5),ef(6))
end
```

4. CONCLUSIONS

Numerical method has the advantage that the computer program developed by the author, leads to solutions of the problem that converge to the "exact" solution. The paper presented, is a novelty in terms of adapting to a full calculation of continuous beams regardless of physical-mechanical properties of materials they are made.

The main steps that were followed in this program by the author are:

-stiffness matrices-writing of the elements composing the structure of the continous beam;
-calculation of the cosine directors and transformation matrices;
-matrix assembly of each beam in the global stiffness matrix of the structure;
-establishment of nodal forces for the entire structure;
-application related conditions;
-determining the nodal equilibrium equations system;
-determining the efforts and the tension at each beam ends.

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THE EFFECT OF AGITATOR SHAFT SPEED ON ENERGY CONSUMPTION OF A BALL MILL

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ABSTRACT

A laboratory ball mill refiner for chocolate and confectionery fat fillings consisting of vertical cylinder, equipped with a rotating shaft with arms, and filled with steel balls as a grinding medium has been used in the experiments. In this type of size reducing equipment, the feed material is comminuted between the moving media, the stirrer and the grinding chamber wall by compression and shear. The aim of the study was to examine the effect of agitator shaft speed on energy consumption of a laboratory ball mill. With constant mass of the steel balls (30 kg), the agitator shaft speed was increased from 10% to 100% of the maximum speed which coresponds to a speed of 50 rpm. The power consumption [W] was recorded upon which milling energy consumption [J/kg] has been calculated. The results were statistically analyzed using ANOVA. The increase of the agitator shaft speed, in steps of 10% to the maximum speed of 50 rpm, led to a statisticaly significant increase in milling energy consumption.

1. INTRODUCTION

Particle size distribution of solids is often an important quality factor while various types of size reducing equipment are used. Comminution equipment can be classified according to the process, the maximum size of product or by the predominant stress causing the comminution [1]. Size reduction is achieved by mechanical forces (compression, impact, and shear) that cause rupture. In any practical machine usually one of the forces is dominant and more important than the others [2].

Size reduction is also a very important unit operation in the production of chocolate (refining phase). During this operation cocoa solids and sugar crystals are reduced to the size that makes them small enough not to be detected on the tongue [3]. Usually it is carried out in a five roll mill with feed roll gap and roll speed as adjustable parameters [4]. It is followed by the phase of conching in which chocolate aroma is fully developing, and the newly created surface during the size reduction is covered with fat improving the flow properties [5]. However, these traditional production lines are relatively expensive with regards to investment, conduction and energy consumption especially for the medium-small size companies [3].

The objective of any kind of industrial production is to achieve high capacity, good product quality, followed by low investment and energy costs. New concepts and ideas only have chance of being successful if the yield as well as the quality of the finished products are not affected and requirements such as reduction of investment, operating and maintenance cost are met. Over the years possibilities and solutions have been sought out in order to find the alternative to traditional process and make it more efficient. The most common ones are based on using a ball mill [5]. They are vertical or horizontal cylinders (stationary tank), equipped with a rotating shaft with arms, filled to as much as 90% of the available volume with grinding media (usually steel balls) [6]. The mass and the balls are agitated by a shaft with arms, rotating at a variable speed [3]. The feed material is comminuted between the grinding media, the stirrer and the cylinder wall by compression and shear [6,7]. This kind of plant also could be used in the production of chocolate surrogates, cacao liquor, creams for

spreading, biscuit coatings and confectionery fat fillings [3]. Nevertheless, only a few papers have been published dealing with the issue of using the ball for these purposes [3,6,7,8].
The aim of this study was to examine the effect of agitator shaft speed on energy consumption of a laboratory ball mill.

2. MATHERIALS AND METHODS

Experiments were conducted using a laboratory ball mill constituted of a double-jacket cylinder, 0,25 m in diameter and 0,31 m in height (0,0152 m^3 in volume), containing 9,1 mm diameter water resistant steel balls and a stirring group. The vertical shaft with horizontal arms, while rotating, puts the steel balls in movement. The experiments were carried out at 35°C with the constant mass of the steel balls m=30 kg. The agitator shaft speed was increased from 10% to 100% (in steps of 10%) of the maximum speed which coresponds to a speed of 50 rpm.

The milling energy consumption, E [J/kg], was calculated by Eq.(1):

$$E = \frac{P\ t}{m} \qquad (1)$$

Here m is the mass of the steel balls (30 kg) and t is the time of the grinding run (180 s) determined by the chronometer. Both m and t were kept constant during all grinding runs. The milling energy consumption during grinding runs was determined using the Network recorder MC750/UMC750 (Iskra MIS, Slovenia). Power readings, P [W], were recorded every 15 s, giving a total of 13 power readings during the 3 min interval of the grinding run. The results are expressed as mean ± standard deviation, as coefficient of variation, and as 95% confidence interval for mean values given by Student's t-distribution. The mean values of corresponding data (P) are used to calculate the milling energy consumption according to Eq.(1). The significance of the the differences between energy consumption obtained with different agitator shaft speeds were statistically analyzed using ANOVA (analysis of variance). All statistical analyses were performed using STATISTICA 10 software.

3. RESULTS AND DISCUSSION

Table 1. shows mean values, standard deviation, coefficient of variation, and 95% confidence interval for mean values given by Student's t-distribution, for the power readings recorded at different agitator shaft speeds. Also, the energy consumptions E [J/kg] calculated according to Eq (1) are given in Table 1.
Standard deviation and coefficient of variation show that at same agitator shaft speed, power readings varied to a extremly small extent with coefficient of variation below 0,3%. It also shows that the power measurements at same agitator shaft speed were highly reproducible. Since the mass of the steel balls (m = 30 kg) and the time of the grinding run (t = 180 s) have been kept constant throught the experiment, the power and energy consumption are directly correlated according to Eq.1 (the correlation coefficient is r = 1). This means that values of the basic statistic parameters, such as coefficient of variation, determined for the power readings can be directly transferred to energy consumption. Also, the correlation between the agitator shaft speed and power as well as the agitator shaft speed and energy consumption are very high (r = 0,996) giving almost a linear response as can be seen from figure 1.

Table 1. Power readings, energy consumption and basic statistical parameters

Power reading [W]	Agitator shaft speed - % of the maximum speed of 50 rpm									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
1.	167,3	186,5	221,7	262,2	299,7	337,9	367,2	408,7	458,6	512,0
2.	167,3	185,8	221,4	262,7	299,2	337,0	366,0	408,5	458,4	511,3
3.	167,5	186,3	221,7	262,4	298,3	337,4	366,7	406,8	459,5	510,3
4.	167,8	186,5	221,4	261,7	298,3	336,5	366,0	407,5	458,1	511,1
5.	167,5	186,5	221,0	262,0	298,1	337,2	366,7	406,3	456,7	511,1
6.	167,5	187,0	220,7	262,7	298,3	336,5	367,0	406,6	457,7	511,1
7.	168,0	187,7	221,2	262,4	297,8	334,9	366,7	407,3	457,0	510,2
8.	167,3	186,5	221,2	261,5	298,5	336,3	365,3	406,1	457,2	508,8
9.	168,2	186,7	221,9	262,2	297,8	335,3	365,3	405,3	457,2	511,6
10.	168,5	187,7	221,7	261,5	298,8	336,3	365,8	406,3	455,8	510,4
11.	168,2	187,0	221,0	262,0	297,6	337,2	365,3	406,3	456,3	508,3
12.	168,2	186,7	220,7	262,0	298,0	337,0	365,8	407,1	456,5	509,2
13.	168,2	186,3	221,8	261,3	297,1	336,5	364,4	406,1	457,3	509,7
Mean value ± SD	167,81 ±0,43	186,71 ±0,54	221,34 ±0,41	262,05 ±0,45	298,27 ±0,68	336,61 ±0,82	366,01 ±0,82	406,84 ±0,97	457,41 ±1,03	510,39 ±1,13
CV	0,254	0,288	0,185	0,172	0,229	0,245	0,223	0,239	0,225	0,221
CI	167,81 ±0,25	186,71 ±0,33	221,34 ±0,25	262,05 ±0,27	298,27 ±0,41	336,61 ±0,50	366,01 ±0,49	406,84 ±0,59	457,41 ±0,62	510,39 ±0,68
Energy consumption E [J/kg]	1006,8	1120,2	1328,0	1572,3	1789,6	2019,7	2196,1	2441,0	2744,4	3062,3

SD - standard deviation
CV - coefficient of variation
CI - 95% confidence interval given by Student's t-distribution

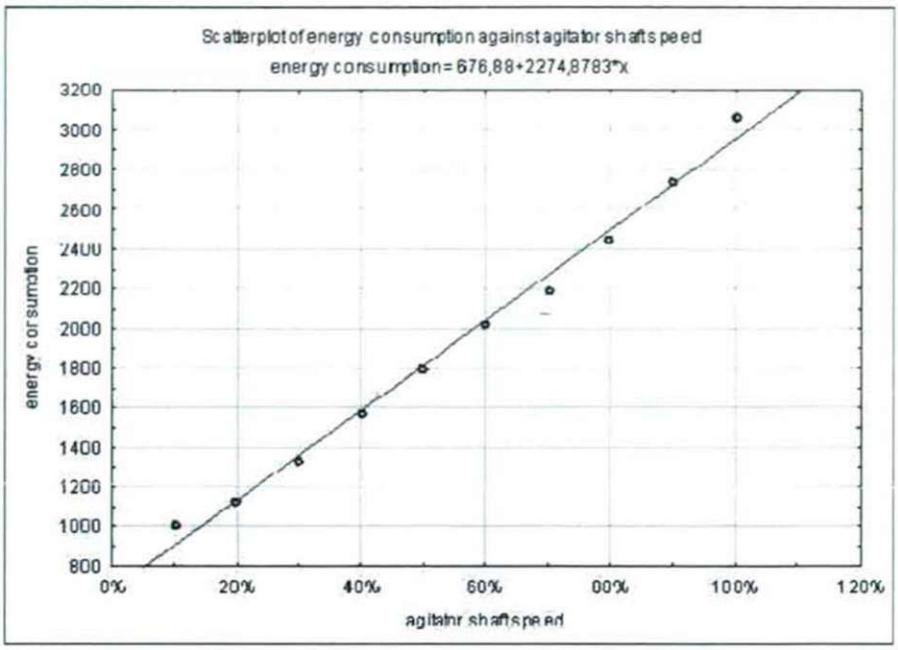

Figure 1. Effect of agitator shaft speed on milling energy consumption

Since power requirements and energy consumption are directly correlated, they both exhibited similar relationship as agitator shaft speed was altered. Increase of the agitator shaft speed from 10% to 100% (50 rpm) let to an increase in power requirement and milling energy consumption (table. 1). The results of the analysis of variance show that for every increase of 10%, increase in power requirements and milling energy consumption is statisticaly significant ($p<0,05$).

During any comminution operation, both material properties and milling methods affect particle breakage [9]. The factors affecting particle size reduction can be classified into those arising from the pshysicochemical properties of the material and those related to the design and operation of the milling equipment [10]. Beside energy consumption, the agitator speed also influences the magnitude of the stress and the relative contributions of compressive and shearing forces. The magnitude and the nature of the forces acting on particles will determine the degree of particle size reduction and energy required for grinding. In practice, the agitator should be run at lowest possible speed to meet the requirements of the process. However, in some cases, with slow agitator the particle size of the product and demands for increased capacity could not be met.

4. CONCLUSION

The consumption of energy in the process, esspecially in the process where large part of it is energy required for grinding, should be kept at the lowest possible level. The agitator shaft speed significantly influence the energy consumption of the ball mill. Therefore, the agitator should be run at lowest possible speed to meet the degree of particle size reduction that is needed (or any other product quality parameter), and handle the capacity of the process.

ACKNOWLEDGMENTS

The authors highly appreciate financial support of the Provincial Secretariat for Science and Technological Development of the Government of Autonomous Province of Vojvodina, Republic of Serbia, project: Cookies and creckers with functional characteristics aimed for consumers with special diatery needs.

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THE EFFECT OF CONSUMER ETHNOCENTRISM ON THE EVALUATION OF FOOD PRODUCT ATTRIBUTES

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ABSTRACT

Nowadays it is a typical food consumption trend, that beside the delectability of foods (taste, odour, colour, etc.) the convenience (ready-to-eat food; fast food, catering etc.), health (traceability, additive free foods, food components, etc.) and ethical attributes (preference of national, regional products, fair-trade, sustainable consumption, etc.) are highlighted, too. Foodstuffs' confidence and information search attributes came to the front instead of experience characteristics during consumers' food choosing decisions. In the local products, different trends are manifest.

Consumer ethnocentrism strengthens the preference of home products, because consumers suppose, that if one prefers national products to foreign ones, it supports the home country's economy and choosing foreign product can be harmful for the economy. According to previous researches, ethnocentrism influences the evaluation of home products in a positive way (Sharma, Shimp and Shin, 1995; Balabanis and Diamantopoulos, 2004).

Ethnocentrism is a global phenomenon, but there are several attributes, which influence the degree of ethnocentrism: demographic factors, culture, lifestyle, economic development. The population of developed countries is more ethnocentric, than the population of less developed countries. The more import products threaten the economic situation of the country, the more the ethnocentrism influences product choice. (Sharma, Shimp and Shin, 1995; Balabanis and Diamantopoulos, 2004) According to the relevant surveys elder consumers are more ethnocentric, than younger, because they are more conservative keep habits and traditions and rejecting modern values (Javalagi, 2005; Witkowski, 1998; Malota, 2003).

The aim of our present research is to determine the ethnocentrism's impact on product preferences and how the locality appears as a viewpoint on food product choices in case of young (18-26 years) consumers. The survey was carried out in three countries. Two post-socialist countries, who accessed EU 'newly': Hungary (Szent István University) and Poland (Warsaw University of Life Sciences) and one 'old EU member state': Germany (University of Hohenheim). Standardized questionnaire was used for the survey, data were analysed by SPSS17.0 software.

1. INTRODUCTION

According to the definition, consumer ethnocentrism strengthens the preference of home products, because consumers suppose, that if one prefers national products to foreign ones, it supports the home country's economy and choosing foreign product can be harmful for the economy. According to previous researches, ethnocentrism influences the evaluation of home products in a positive way (Sharma, Shimp and Shin, 1995; Balabanis and Diamantopoulos, 2004). Ethnocentrism is a global phenomenon, but there are several attributes, which influence the degree of ethnocentrism: demographic factors, culture, lifestyle, economic development. The population of developed countries is more ethnocentric, than the population of less developed countries. The more import products threaten the economic situation of the country, the more the ethnocentrism influences product choice. (Sharma, Shimp and Shin, 1995; Balabanis and Diamantopoulos, 2004) According to the relevant surveys elder consumers are more ethnocentric, than younger, because they are more conservative keep habits and traditions and rejecting modern values (Javalagi, 2005; Witkowski, 1998; Malota, 2003).

The Consumer Ethnocentric Tendencies Scale (CETSCALE) is a 17-item measure, of consumer ethnocentrism, that was developed by Shimp and Sharma (1987), in the USA, and was tested by several researches. First, it was tested on students in the USA, in Japan, in Sweden and in Spain. Steenkamp used the CETSCALE to compare the ethnocentric tendency in four European countries (Greece, Belgium, Great Britain and Spain) in 1993. (Steenkamp, 1997). Witkowski (1998) tested the scale in Hungary to compare the Hungarian and Mexican consumers' ethnocentrism. According to this survey Hungarians were less ethnocentric, than Mexicans. Lindquist et al. (2001) tested the shortened 10 item CETSCALE on student sample, in three Central European countries: in Hungary, Czech Republic and Poland. Previously Shimp with Sharma (1987) and Steenkamp with Baumgartner (1998) used the shortened scale successfully. The measured dimensions of consumer ethnocentrism were: product availability, effect on employment, patriotism and effect on economy. According to Lindquist et al. (2001) the shortened scale can be effective with some modification and complementation with situation depending statements. Malota (2003) criticised the CETSCALE similarly: the scale was developed adjusting on American circumstances, it might be necessary to modify it depending on the given circumstances.

Juric and Worsley (1998) examined the effect of country of origin on the judgement of imported foodstuffs in case of 315 consumers from New Zeland. Based on the researches of Wall and Heslop (1986) the following dimensions were used for the examination of the effect of ethnocentrism on product evaluation:

- Patriotic reasons
- Protect local employment
- Quality of local products as good as imported products
- Local foods are safer
- Don't want money out of the country

Juric és Worsley (1998) measured the attitudes on five-point Likert scale. The results show, that there is a negative relation between the ethnocentrism and the judgement of imported food products' quality and the most determining dimension was the patriotism. According to the authors, it is worth to examine separately the different quality attributes, instead of the overall product quality.

2. METHOD

Based on the reviewed methodological viewpoints (Lindquist et al.; 2001, Malota; 2003, Juric and Worsley; 1998) a scale was developed to measure the dimensions of ethnocentrism. The scale consists of the following dimensions:

Affective dimension (patriotic reasons)

- I consider it is important, that the Hungarian/Polish/German customers prefer the Hungarian/Polish/German products.
- I consider that purchasing Hungarian/Polish/German products is patriotic.
- I like traditional brands, products.

Economic impact

- Only those products should be imported, which cannot be manufactured by the Hungarian/Polish/German producers. (overall economic impact)
- We should purchase products manufactured in Hungary/Poland/Germany instead of letting other countries get rich off us. (overall economic impact)
- Purchasing foreign products hurts Hungarian/Polish/ German economy and causes unemployment. (impact on employment)

- It is not right to purchase foreign products, because it puts Hungarians/Poles/Germans out of jobs. (impact on employment)

Product evaluation

- Domestic foodstuffs may hurt consumers' health less, than the imported foodstuffs.
- Domestic foodstuffs have better quality, than foreign foods.
- I prefer domestic foodstuffs, even if it is more expensive, than imported products.

The survey was carried out in three countries. Two post-socialist countries, who accessed EU 'newly': Hungary (Szent István University) and Poland (Warsaw University of Life Sciences) and one 'old EU member state': Germany (University of Hohenheim). The questionnaire was translated into the native language and back-translated into Hungarian by bilingual natives.

The scale was tested by confirmatory factor analysis (Extraction Method: Maximum Likelihood, Varimax rotation). After, for the further analysis Principal Component Analysis, K-means Cluster Analysis was used. Data were analysed by SPSS17.0 software.

The acceptance of the factor analysis based on the following statistical criteria: Kaiser-Meyer-Olkin Measure of Sampling Adequacy: 0,5<; extraction communalities: 0.25<=; goodness of fit test: 0.000<; cumulative variance: 33%<. The acceptance of Principal Component Analysis based on the following criteria: extraction communalities: 0.25<=, cumulative variance: a principal component can be acceptable, if a component implies the half of the full information content, but at least 33% (Székelyi – Barna, 2002).

Cronbach's Alpha was used to measure the reliability of the scales, crated by Principal Component analysis. According to Rózsa et al. (2006) the level of the reliability depends on, what we measure. Psychological categories are less obvious and objective, than physical science categories, that is the reason why more difficult to measure. While the level of the acceptable reliability in physical science is 0.7, in case of an attitude measuring scale 0.5 level of reliability can be acceptable. The more statements the scale contains, the higher is the value of Cronbach' Alpha. (Malhotra, 2001)

3. RESULTS

3.1. Main results of the Factor Analysis

As the results of the factor analysis (Extraction Method: Maximum Likelihood, Rotation Method: Varimax with Kaiser Normalization), three factors were created in case of each country. The factor structures only partly corresponded with the theoretical dimensions, because according to the factor loadings some variables belonged to two factors (there was no double difference between the factor loadings of certain variables on the factors.). In this way 'affective' and the 'economic impact' dimensions did not separate clearly by the factor analysis. Based on these results, and for further analysis (ex. Pathway analysis) Principal Component Analysis was used to create the dimensions of ethnocentrism.

3.2. Results of the Principal Component Analysis

The results of the PCA analysis confirmed the theoretical grouping of the statements regarding 'Economic Impact' and 'Product Evaluation'. In case of the Polish and German 'Affective component', statistical conditions (cumulative variance and Cronbach's Alpha) shows weaker reliability, but in case of attitude measurement these statistical conditions can be acceptable. (Székelyi-Barna, 2002; Rózsa et. al, 2006) The cumulative variance is roughly 50% (which is higher than the criteria 33%), that is the reason why the component is acceptable.

Table 1. Loadings of 'Affective component'

	Hungary	Poland	Germany
I consider it is important, that the Hungarian/Polish/German customers prefer the Hungarian/Polish/German products.	.799	.785	.794
I consider that purchasing Hungarian/Polish/German products is patriotic.	.796	.769	.478
I like traditional brands, products.	.661	.511	.773
Cumulative %	56.954%	48.948%	48.508%
Cronbach's Alpha	.616	.470	.455

Extraction Method: Principal Component, extraction communalities: 0.25<

In case of the Hungarian and Polish sample the loadings of 'Affective' component are roughly similar (Hungarians are a bit higher). While in case of the German sample the loading of 'I consider that purchasing German products is patriotic' is quite low, what suggests that this statement fits less into the statement list. Besides this the preference of traditional products rather determining in the German sample than the Polish, where this statement is the less dominant.

Table 2. Loadings of 'Economic impact'

	Hungary	Poland	Germany
We should purchase products manufactured in Hungary/Poland/Germany instead of letting other countries get rich off us. (overall economic impact)	,831	,781	,766
It is not right to purchase foreign products, because it puts Hungarians/Poles/Germans out of jobs. (impact on employment)	,820	,766	,813
Only those products should be imported, which cannot be manufactured by the Hungarian/Polish/German producers. (overall economic impact)	,783	,646	,690
Purchasing foreign products hurts Hungarian/Polish/ German economy and causes unemployment. (impact on employment)	,766	,764	,785
Cumulative %	64,068%	54,949%	58,519%
Cronbach's Alpha	,813	,722	,757

Extraction Method: Principal Component, extraction communalities: 0,25<

According to the loadings and the cumulative variances, statements regarding the economic impact determine the component well, in case of each country, and there were no high differences among the components of the countries.
As in case of the first two dimensions, the items of 'Procduct evaluation' are more consistent in the Hungarian sample, than in the other two samples.

Based on the created principal components, K-mean cluster analysis was carried out to find consumer behaviour types along the created components. We differentiate four consumer segments in case of each country, because this number of clusters was the most interpretable and show really homogeneous F-scores. The name of the clusters are the following: 'product centric', an 'ethnocentric', an 'economically concerned' and a 'dismissive' segment.

Table 3. Loadings of 'Product evaluation'

	Hungary	Poland	Germany
Domestic foodstuffs have better quality, than foreign foods.	.857	.846	.804
I prefer domestic foodstuffs, even if it is more expensive, than imported products.	.809	.694	.685
Domestic foodstuffs may hurt consumers' health less, than the imported foodstuffs.	.792	.815	.784
Cumulative %	67.175%	62.060%	57.692%
Cronbach's Alpha	.747	.689	.631

Extraction Method: Principal Component, extraction communalities: 0,25<

Table 4. Final Cluster Centres Hungary N=478

	Cluster					
	Product centric N=113 (23.6%)	Ethnocentric N=158 (33.1%)	Economically concerned N=133 (27.8%)	Dismissive N=74 (15.5%)	F	Sig.
Affective component	-.34334	.91227	.01219	-1.46540	276,130	,000
Economic effect	-.70555	.88787	.23145	-1.23236	265,658	,000
Product evaluation	.15634	.98704	-.63026	-1.17737	300,029	,000

Table 5. Final Cluster Centres Poland N=503

	Cluster					
	Product centric N=118 (23.5%)	Ethnocentric N=114 (22.7%)	Economically concerned N=159 (31.6%)	Dismissive N=112 (22.3%)	F	Sig.
Affective component	-.16061	.96277	.23269	-1.14812	192,521	,000
Economic effect	-.51216	1.03411	.31188	-1.01255	233,140	,000
Product evaluation	.70356	1.00984	-.48661	-1.07185	360,503	,000

Table 6. Final Cluster Centres Germany N=398

	Cluster					
	Product centric N=80 (20.1%)	Ethnocentric N=102 (25.6%)	Economically concerned N=126 (31.7%)	Dismissive N= 90 (22.6%)	F	Sig.
Affective component	-.24444	.90215	.34790	-1.28648	222,646	,000
Economic effect	-.71313	.98886	.31009	-.91472	177,078	,000
Product evaluation	.54197	1.02959	-.38193	-1.14887	275,710	,000

The 'product centric' segment evaluated the statements regarding product evaluation high, and the other two components are less important for them. If we compare the three countries, Hungarian 'Product centric' segment gave the lowest score for the 'product evaluation' component. This suggests that the Hungarian product centric segment is less committed, than the other two countries' segment.

The 'ethnocentric' segments evaluated all of the three components highly, what suggests an aware consumer attitude. For the Hungarian 'ethnocentric' consumers the 'product evaluation' and the 'affective components' are the most important, while in case of the other two countries the 'product evaluation' and the 'economic impact' are more dominant.

The most determining factors for 'economically concerned' segment both the 'economic impact' and the 'affective component'. Although the 'economic impact' is the most determining component, the 'affective component' is important also, what is confirming the result of the factor analysis: there is a strong relationship between the dimensions.

The 'dismissive' consumer group evaluated all the three dimensions low. Presumably, they are not interested in home product choosing.

4. CONCLUSION

Based on the reviewed methodological viewpoints a theoretical scale was developed to measure the dimensions of ethnocentrism, which dimensions were: Affective dimension (patriotic reasons), Economic impact and Product evaluation. As the results of the confirmatory factor analysis, three factors were created in case of each country. The factor structures only partly correspond with the theoretical dimensions. The most important difference, that the 'affective' and the 'economic impact' dimensions were not separated by the factor analysis, while product evaluation separated clearly.

As the results of the Principal Component analysis differences can be observed between the countries. In case of the German respondents 'Affective component' is rather defined by the preference of traditional products, than the patriotic feelings, while in case of the other two countries patriotic feeling is more dominant, than the preference of traditional brands. In case of the 'Economic impact' component statements regarding the impact on employment are a bit more deterministic in case of the German component, than in case of the components of the other two countries. In case of the Hungarian 'Product evaluation' component the statement regarding food safety have the lowest loading, but in case of the Polish and German components the less deterministic is the price statement.

Based on the created principal components, we could differentiate four consumer segments in case of each country: a 'product centric', an 'ethnocentric', an 'economically concerned' and a 'dismissive' segment. These segments show that we can differentiate young consumers according to their ethnocentric attitudes.

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THE UTILIZATION OF POTATO IN PUBLIC CATERING - THE ROLE OF QUALITY ASPECTS

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ABSTRACT

Our study was carried out in the framework of the 'Development of potato growing technologies and trademarks' Hungarian national project. The aim of the project is to improve the national and international competitiveness of the Hungarian potato sector.
Nowadays, catering sector has growing share in food supply, and potato is a widely popular foodstuff in Hungary in everyday meal. Our aim is to examine, which factors (economic, attitude, knowledge etc.) help, or obstruct prevailing quality viewpoints in potato utilization in public catering sector.

A standardized questionnaire was used for the examination. The questionnaires were filled out on the 'Forum of public catering managers' in the autumn 2010. 118 questionnaires were collected; most of the catering kitchens in the sample were operated by local governments, catering more than 100 people.

The questionnaire includes the following topics: questions regarding the potato suppliers; questions regarding the potato utilization; the popularity of the potato and the trends in public catering; the willingness to use potato labelled with quality certification mark; questions regarding the workplace of the respondent; socio-demographic questions regarding the respondent.

Before our research, public procurement was obligatory in public catering, which has been cancelled. This new situation provides opportunity for public catering to choose new suppliers. At the present time the suppliers of public catering are mostly wholesale dealers and large scale growers. 46% of the respondents answered, that they would choose other supplier, for favourable price and quality, but only 56% of the catering managers can influence the decisions regarding the selection of the suppliers. According to the respondents there was no change in quantity and quality of the potato used in public catering, potato is as popular foodstuff nowadays, as before. From the point of our research it is favourable, that catering managers consider differentiating potato types (boiling type, baking type, salad potato) as an important matter, however, this is totally missing in the practice. The reasons of the wrong practice are: the lack of knowledge regarding the potato varieties; the lack of the suppliers' differentiated supplies; the limited resources for the purchase. Public catering sector is open for the utilization of a high quality Hungarian potato variety, but due to the obstructing factors, fast improvement cannot be foreseen in this matter.

1. INTRODUCTION

Potato is one of the most important foodstuff all over the world. It can be prepared variously, it is easily digestible, contains valuable proteins and fiber, and it has high nutrition value.

According to estimations, the number of potato varieties is around 3000 variety in the world. In Hungary the number of certified potato varieties is 44 at present time, and only 11 of them are Hungarian (Balatoni rózsa, Hópehely, Démon, Katica etc.) varieties, the rest are mostly Holland ones: Desirée, Kondor, Cleopátra. (Izsáki, 2004) The average yield of potato in Western-Europe is 40t/ha steadily, while this number in Hungary is only around 25t/ha. (Ábrahám, 2009) Potato consumption in the world is 218 million tons. In Hungary the potato consumption per capita has continuously decreased since 1934. A small increasing was seen in the '90s and nowadays it is stagnant on 60-65kg per capita per year. (Ábrahám, 2009) The reason of the decreasing potato consumption is the transformation of the income relations. As the consumers' disposable income is increased, the structure of the consumption is transformed: rather the quality, than the quantity of the foodstuffs comes into the foreground

and other kind of vegetables (ex. rice) appear increasingly in the meal. (Földi, 2007) The most important viewpoint in case of purchasing fruits and vegetables for the Hungarian consumers is the suitable price value-ratio. Potato consumption is 36% of the whole vegetable consumption, thus potato is the most frequent purchased vegetable in Hungary (Gfk, 2011). But unfortunately, there is a lot of imported potato in the Hungarian market, and there is a wrong practise, that Hungarian consumers dislike potato with yellow shell, and consumers don't know the differences between the potato types.

Our study was carried out in the framework of the 'Development of potato growing technologies and trademarks' Hungarian national project. The aim of the project is to improve the national and international competitiveness of the Hungarian potato sector. Two trademarks will be developed in the framework of the project: 'Keszthely seed-potato' and 'Delicious culinary potato'.

Three actors of food chain were examined: potato growers; the catering sector (public catering); and the consumers.

The present study examines the situation in the catering sector: which factors (economic, attitude, knowledge etc.) help, or obstruct prevailing quality viewpoints in potato utilization. Before our research, public procurement was obligatory in public catering, which has been cancelled. This new situation provides opportunity for public catering to choose new suppliers.

2. METHOD

A standardized questionnaire was used for the examination. The questionnaires were filled out on the 'Forum of public catering managers' in Budapest and in Szeged, in the autumn 2010 by catering managers. The questionnaire includes the following topics: questions regarding the potato suppliers; questions regarding the potato utilization; the popularity of the potato and the trends in public catering; the willingness to use potato labelled with quality certification mark; questions regarding the workplace of the respondent; socio-demographic questions regarding the respondent.

3. RESULTS AND DISCUSSION

3.1. Characterization of the sample

118 questionnaires were collected; most of the catering kitchens in the sample were operated by local governments and catering more than 100 people.

3.2. Questions regarding the practice of potato usage

On the 1st of August in 2011, a directive was designed for the public catering sector, about the proposed quantity of different foodstuffs and nutrition value. According to this guideline, in case of 10 catering days maximum 5 times (in case of one meal per day) it is proposed to use potato for dish.

According to the answers of catering managers, catering kitchens use potato a bit more frequently, than the proposal: In case of five catering days (N=91), 52 kitchens use potato 2-3 times, and 28 kitchens 3-4 times in a week for meal. In case of seven catering days (N=35) 25 kitchens cook potato 3-4 times in a week.

Table 1. Characterization of the sample

Institute of the public kitchen	Frequency	Operator	Frequency
Primary school	74 (62.7%)	Local government	82 (72.6%)
Nursery	70 (59.3%)	Large scale entrepreneur	12 (10.6%)
Workplace catering	63 (53.4%)	Small scale entrepreneur	11 (9.7%)
Old age home	49 (41.5%)	Network operator	6 (5.3%)
Secondary school	29 (24.6%)	Church	2 (1.8%)
Play-school	22 (18.6%)	**Catering number**	**Frequency**
Hospital	5 (4.2%)	50-100 capita	6 (5.1%)
Prison	2 (1.7%)	101-200 capita	20 (17.1%)
University, College	1 (0.8%)	201-500 capita	37 (31.6%)
Police	1 (0.8%)	501-1000 capita	31 (26.5%)
other	5 (4.2%)	>1000 capita	23 (19.7%)

3.3. Questions regarding the potato suppliers

Most of the catering kitchens (56%) have only one supplier and 21-23% use two, or more suppliers. At the present time the suppliers of public catering are mostly wholesale dealers (76,3%) and large scale growers (47,5%). 60% of the catering kitchens purchase potato weekly, and 17% purchase more than once in a week. The rest purchases potato monthly (20%) or rarely. This purchasing practise (smaller quantity more frequently) is favourable from the viewpoint of small scale growers. 46% of the respondents answered, that they would choose other supplier for favourable price and quality, but only 56% of the catering managers can influence the decisions regarding the selection of the suppliers. The most important criteria in case of choosing supplier are: the good quality, the flexibility, the price, the delivery timing and the reliability.

66% of the respondents mentioned, that they have had any problem with their potato supplier. The reason of the complaint were quality problems, mostly: health condition of the potato (35,6%) , problems with any quality attributes (29,7%) or mechanical injury (24,6%).

In 2009 39% of the catering kitchens purchased the potato at 60-80Ft/kg (0.2-0.27 Euro/kg) price level and 24.3% bought it more expensively, than 80Ft/kg (>0.27 Euro/kg). 28.7% of the kitchens purchased the potato at lower price level, than 60 Ft/kg (<0.2 Euro/kg). The more frequently the kitchen purchase potato, the higher price they pay for it, and those, who buy it at a lower price, more frequently give potato dish for the customers.

The next figure shows the catering managers' average satisfaction with the quality of the used potato in 2009.

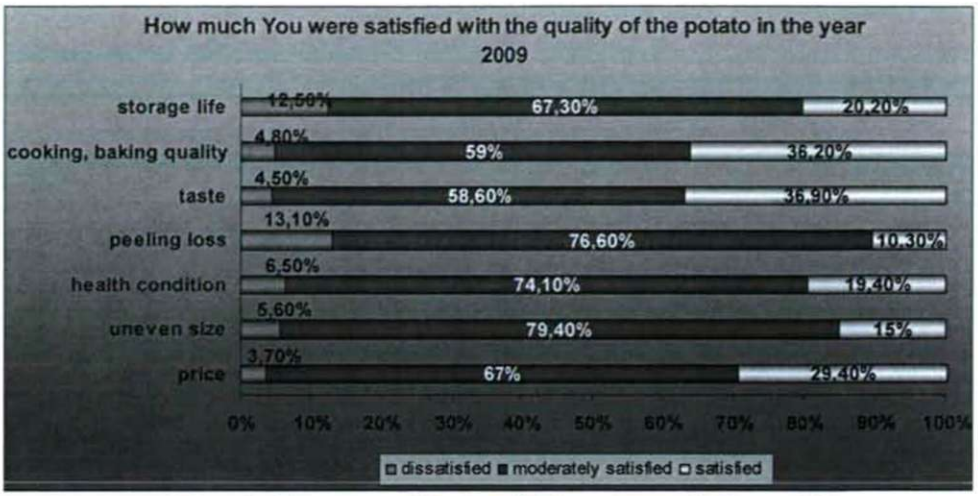

Figure 1. The average satisfaction with the used potato in the year 2009

As the figure shows, most of catering managers are moderately satisfied with the quality of the potato. But as the following results will show, due to the lack of adequate knowledge, presumably they did not have high expectations regarding the potato quality attributes. Apart from this, it seems favourable, that catering managers accept the price-quality ratio of the used potato.

3.4. Questions regarding the knowledge of potato varieties and types

According to the answers to the questions which tested the knowledge on the used potato types, catering managers do not have adequate knowledge.

Only 34.7% of the respondents answered 'yes' to the question 'Do you know the potato variety what you use in the catering kitchen?'. Most of them answered, that the used types of potato are 'Desiree, 'Kondor' and 'Rózsa', however there is no 'Rózsa' variety on the market. 46.6% of the respondents answered, that the used potato is a Hungarian variety, but Desiree is correctly a Dutch variety.

41.7% of the catering managers stated, that they used different types of potato in catering, but only 4 person answered, that she knew the so called 'potato ABC', what is the grouping of the potato varieties by the usage type: boiling, cooking and salad potato.

According to the respondents, the main barriers of the potato purchasing by usage types, are the lack of the suppliers' differentiated supplies (53%); the limited financial resources (28.8%); the lack of knowledge about the potato types (27.1%).

3.5. The innovation attitude of the catering managers

The innovation attitude of the catering managers was measured by questions regarding the demand of adequate information on the potato quality and the intention to change the present practice.

Catering managers consider the labelling of potato important, especially the origin of the products. The labelling of potato usage types and potato varieties are considered important, too. (Table. 2)

Table 2. The importance of product labelling
(5 point Likert scale; 1= I don't agree al all; 5= I'm totally agree)

Statement	Mean
The origin of the product should have to be labelled on the product.	4.71
The usage type of the potato should always be labelled on the product (cooking, boiling and salad).	4.50
The name of the potato variety should always be labelled on the product.	4.36

As the result shows, catering managers prefer Hungarian products and raw materials, and they consider necessary to use quality mark to differentiate Hungarian high quality potato. As the respondents answered (Table 3), they are opened to use quality mark labelled potato even if it is a bit more expensive, than the potato used before. But, we have to represent this statement carefully, because, as we mentioned before, one of the major barriers of the quality improvement in the public catering sector is the limited financial opportunities.

Table 3. The willingness to use Hungarian quality mark labelled potato in the public catering sector
(5 point Likert scale; 1= I don't agree al all; 5= I'm totally agree)

Statement	Mean
If the parameters (quality, price) are the same, I prefer Hungarian products.	4.91
As in case of the popularity of the 'Excellent Hungarian Quality Product' logo, it would be necessary to use quality mark in case of Hungarian potato. This would be an important step toward potato consumption culture improvement.	4.68
I would like to use quality mark labelled potato in the catering kitchen even if somewhat more expensive.	4.37

As Table 4 shows, catering managers are open to improve their knowledge on potato varieties and usage types and other areas of food and agriculture.

Table 4. The willingness to improve knowledge
(5 point Likert scale; 1= I don't agree al all; 5= I'm totally agree)

Statement	Mean
Usually I learn something new and try other practises with pleasure because we have to improve.	4.78
It would be a pleasure to take part in programs, aiming at supporting Hungarian agriculture.	4.7
It would be a pleasure to take part in a program, which shows the cooking and baking characteristics of potatoes with different usage types.	4.56
The differences between the potato usage varieties would have to be known by the workers in public catering.	4.03

4. SUMMARY

Catering managers – satisfying customers needs - offer potato dishes for their customers frequently, but their knowledge on the different potato types is not sufficient. However, respondents are open to improve their knowledge, and they would use suppliers, which can offer differentiated potato supply. The present purchasing practise (smaller quantities more frequently) is favourable from the viewpoint of small scale growers.

The most frequent barriers of purchasing potato by usage types are lack of the suppliers' differentiated supplies; the limited financial resources and the lack of knowledge about the potato varieties and types.

The attitude of the catering managers shows the opportunity for change: catering managers welcomed the mark labelled Hungarian potato varieties, and they would favourably improve their knowledge on potato varieties and usage types.

It would be necessary to train catering managers in order to improve their knowledge and form their views on the potato use.

Public catering sector is open for the utilization of a high quality Hungarian potato variety, but due to the obstructing factors, fast improvement cannot be foreseen in this matter.

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TECHNIQUES FOR REMOVING NITROGEN AND PHOSPHORUS THROUGH CHEMICAL ADDITION

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ABSTRACT

The present paper brings to the attention of the specialists in the field the main physical and chemical techniques for removing nitrogen and phosphorus from residual waters, providing exploitation details for each technique. These techniques belong to the category of advanced sewage treatment technologies. The serious problems related to water protection led to some severe restrictions regarding the concentration level allowed in the purified effluent discharged in the natural outlets.

1. INTRODUCTION

Residual water contains a series of pollutants, among which some are removed more or less during the conventional sewage treatment stages, while others are retained for a very short time or at all in the classical sewage treatment stations. The serious problems related to water protection led to some severe restrictions regarding the concentration level allowed in the purified effluent discharged in the natural outlets, restrictions that are shown in tables 1 and 2[1, 6, 12].

Table 1. Quality restrictions for CBO_5 and O_2, in surface waters

Water characteristics	Usage categories		
	I	II	III
O_2 , [mgf/dm^3], minimum	6	5	4
CBO_5, [mgf/dm^3], maximum	5	7	12

Table 2. Maximum suspension quantities, possibly discharged in outlets, according to the dilution degree

Usage categories			Dillution degrees
I	II	III	
Maximum suspension quantities [mgf/dm^3]			
20 – 40	25 – 60	30 – 100	0 – 20
40 – 100	60 – 150	100 – 250	20 – 50
100 – 300	150 – 450	250 – 750	50 – 150
300 – 1.000	450 – 1.500	750 – 2.500	150 – 500

After being mixed with residual water, the outlet water should have the pH between 6,5 – 9,0.

Identifying the existing pollutants in the mechanic-biologic discharged effluent and the effects they have on the environment is highly important in establishing the advanced treatment methods, in order to obey the quality standards in force. Table 3 shows the characteristics of residual water treated mechanic-biological, as well as the effects they have on the environment and human health.

It should be mentioned that the potential effects of residual substances existing in mechanic-biologic effluents can vary significantly. Although solid suspensions and biodegradable organic compounds are retained especially through mechanic-biologic treatment, there are some instances in which extra retaining in imposed. Initially, around mid 60's, nitrogen and phosphorous compounds from residual water discharges have triggered attention due to their effect in accelerating the lakes eutrophication and stimulating the aquatic mediums. At the moment, in the countries where the treatment of residual water is very advanced, controlling the nutrients has become a common technique of residual sewage treatment, especially in the instances of refilling the subterranean water provisions. Nitrifying the residual water is also necessary in many instances for reducing the ammonia toxicity or reducing the impact on the oxygen resources in water courses or estuaries. Beginning with the 80's, a special attention is paid to nonmetals, metals, organic compounds, halogenated compounds, pesticides, herbicides, insecticides, and volatile organic compounds, all these pollutants being considered toxic for people and aquatic environment [1, 2, 3, 11].

Although in Romania the advanced treatment of residual water has become more important in the last 10 years, in the world, a series of techniques and technologies were researched, in order to insure that a treatment station effluent has characteristics corresponding to the admitted limits established by quality standards. Globally, for over 40 years, a great diversity of treatment technologies were studied, developed and applied for retaining the pollutants from residual water (suspensions, biodegradable organic substances, pathogenic germs, nutrients, organic or inorganic compounds with cancerous, mutagen, teratogenic action or with high toxicity, refractory substances, heavy metals, dissolved inorganic substances). In table 4 are shown the means of reducing residual pollutants from residual water, through advanced treatment procedures.

Table 3. Pollutants typical for residual water treated mechanic-biologic and their effects

No	Pollutant	Effects
1	Solid suspensions	They can cause sludge deposition or can interact with the outlet.
2	Biodegradable organic compounds	They can deprive the outlets of oxygen resources.
3	Nonmetals, metals, organic compounds, halogenated compounds, pesticides, herbicides, insecticides	They are toxic for people (cancerous) and for the aquatic environment.
4	Volatile organic compounds	They are toxic for people, cancerous.
	NUTRIENTS	
5	Ammoniac	It increases chlorine consumption; it can be turned into nitrates and during the treatment processes it can deprive the resources of oxygen; together with the phosphorous it leads to the development of parasitic aquatic mediums. It is toxic for fish.
6	Nitrates	It stimulates the development of algae and aquatic mediums. With children, they can cause methemoglobinemia.
7	Phosphorous	It stimulates the development of algae and aquatic mediums. It

		interferes with coagulation.
OTHER INORGANIC SUBSTANCES		
8	Calcium and magnesium	They increase water hardening and dissolved total solids.
9	Chlorides	They give water a salty taste. They interfere with agricultural and industrial processes.
10	Sulphates	Cathartic action
OTHER ORGANIC SUBSTANCES		
11	Surfactants	They cause foaming and interfere with coagulation.

Table 4. Means of reducing residual pollutants from residual water, through advanced treatment procedures

No	Objective	Method	Effluent type subjected to advanced treatment
1	Suspension retaining	Filtration	EM, EBD
		Screening	EBD
2	Ammoniac oxidation	Nitrification in biological stage	EM, EBD, EBND
3	Reducing the nitrogen	Nitrification/de-nitrification in biological stage	EM, EBND
4	Reducing the nitrates	Separate phase of de-nitrification in biological stage	EBND and nitrification
5	Reducing P biologically	Reducing P at water surface	AUB, EM
		Reducing P at sludge surface	NAR
6	Biological methods of N and P simultaneous retaining	Reducing P and nitrification/de-nitrification in biological stage	AUB, EM
7	Reducing N by physical or chemical methods	Flash distillation	EBND
		Chlorination at breakpoint	EBND and filtration
		Ions exchangers	EBND and filtration
8	Reducing P by chemical addition	Chemical precipitation with metallic salts	AUB, EM, EBND, EBD
		Chemical precipitation with lime	AUB, EM, EBND, EBD
9	Reducing the toxic organic components and the refractory organic substances	Adsorption on active coal	EBND and filtration
		Activated sludge – powder active coal	EM
		Chemical oxidation	EBND and filtration
10	Reducing the dissolved inorganic substances	Chemical precipitation	AUB, EM, EBND, EBD
		Ions exchangers	EBND and filtration
		Ultra filtration	EBND and filtration
		Inverted osmosis	EBND and filtration
		Electro dialysis	EBND, filtration and adsorption on coal
11	Volatile organic compounds	Volatilization and flash distillation with gas	AUB, EM

EM – effluent of mechanic treatment phase; EBD – decanted effluent of biological treatment phase; EBND – non-decanted effluent of biological treatment phase; AUB – gross residual water; NAR – recirculated activated sludge.

According to the method or the combination of methods chosen, various performances can be obtained regarding the residual pollutants retained during the advanced treatment stage. Table 5 shows the treatment levels (expressed through the concentrations of diverse residual pollutants in the "tertiary" effluent), attained with diverse combinations of procedures and operations used for advanced treatment of residual water.

Table 5. Levels of treatment attained with diverse combinations of procedures and individual operations used for advanced treatment of used water

No	COMBINATION	EFFLUENT QUALITY						
		susp. (mg/l)	CBO_5 (mg/l)	CCO (mg/l)	N total (mg/l)	$N\text{-}NH_3$ (mg/l)	phosphates (mg/l)	turbidity (NTU)
a	Activated sludge and filtration on granular environment	4-6	<5-10	30-70	15-35	15-25	4-10	0,3-5
b	Activated sludge and filtration on granular environment and adsorption on coal	< 3	< 1	5-15	15-30	15-25	4-10	0,3-3
c	Activated sludge and nitrification in a single phase	10-25	5-15	20-45	20-30	1-5	6-10	5-15
d	Activated sludge, nitrification and de-nitrif. in separate phases	10-25	5-15	20-35	5-10	1-2	6-10	5-15
e	Activated sludge and salts addition	10-20	10-20	30-70	15-30	15-25	< 2	5-10
f	Activated sludge, salts addition, nitrification, de-nitrification and filtration	<5-10	<5-10	20-30	3-5	1-2	< 1	0,3-3
g	Biologic reduction of P at water surface	10-20	5-15	20-35	15-25	5-10	< 2	5-10
h	Biologic reduction of N and P at water surface	< 10	< 5	20-30	< 5	< 2	< 1	0,3-3

According to residual pollutants that should be removed and to technical-economical analyses of solutions, there are a multitude of possible combination of procedures and individual operations.

Phosphorous and nitrogen are the main nutrients existent in the effluents treated mechanic-biologic, that are important regarding the advanced treatment. Discharges of residual water containing N and P can accelerate the lakes and accumulations eutrophication and can stimulate the development of algae and aquatic plants.

Besides the fact that they produce an unpleasant aesthetic sight, the presence of algae and aquatic vegetation can affect the use of water resources, especially when they are used as resources for water supply, fish breeding and entertainment.

Significant concentrations of N in the effluent treated mechanic-biologic can have adverse effects including the consumption of oxygen dissolved in the outlets, leading to a toxic aquatic environment, influencing the efficiency of chlorine disinfection, endangering public health and affecting the possibility of reusing the treated residual water.

Nutrients control has become an important objective regarding water quality management and treatment stations design.

2. NUTRIENTS CONTROL STRATEGIES

When choosing the nutrients control strategies it is important to establish: the characteristics of raw residual water, the type of the existing treatment station, the concentrations imposed regarding N and P for the effluent and the necessity of reducing the nutrients seasonal or permanently. Nutrients control ways can imply the introduction of an individual process for controlling a certain nutrient (for example, $Al_2(SO_4)_3$ addition for P precipitation) or can imply the integration of nutrients removing process in the biological treatment phase [6, 9]. On the method and technology chosen, depends the fulfillment of demands imposed, referring to effluent quality, flexibility in operation and cost. Initially, various types of treatment gave used chemical, physical and biological systems for quantities limiting and control or nutrients form from the treatment station effluent. The most often used methods were:

- Nitrification in biological phase for ammonic oxidation;
- Biological de-nitrification using methanol for retaining N;
- P chemical precipitation.

In recent years, a series of biological procedures were developed, centered either on individual retaining of nitrogen or phosphorous or on simultaneous retaining of N and P. These procedures were highly appreciated by specialists in the area, because massive use of chemical reagents has been eliminated or reduced substantially, with all the economical consequences resulting from these.

2.1. Nitrogen control and removal

In untreated residual water, N is found as ammoniac or organic nitrogen, both soluble, as micro-particles. Soluble organic nitrogen is often found as urea or amino acids.

Table 6. The effect of different operations and treatment procedures on nitrogen based compounds [8, 10]

	Treatment operation or procedure	N based compounds			N total retained* %
		N organic	NH_3-NH_4^+	NO_3^-	
	CONVENTIONAL TREATMENT				
1	Mechanic treatment	10–20%	no effect	no effect	5–10%
2	Biologic treatment	15–50%**	< 10%	small effect	10–30%
	BIOLOGIC TREATMENT				
1	Bacterial assimilation	no effect	40–70%	slab	30–70%
2	De-nitrification	no effect	40–70%	80–90%	70–95%
3	Nitrification	limited effect	→ NO_3	no effect	5–20%
4	Oxidation ponds	partial transformation in NH_3-NH_4^+	partially reduced through flash distillation	partially reduced through nitrification /de-nitrification	20–90%
	CHIMICAL PROCEDURES				
1	Chlorination at breakpoint	uncertain	90–100%	no effect	80–95%
2	Chemical coagulation	50–70%	small effect	no effect	20–30%
3	Ions exchangers selective for ammoniac	small, uncertain	80–97%	no effect	70–95%
4	Ions exchangers selective for nitrates	small effect	small effect	75–90%	70–90%

5	Adsorption on coal	30–50%	small effect	small effect	10–20%
PHYSICAL OPERATIONS					
1	Filtration	30–95% from N organic in suspension	small effect	small effect	20–40%
2	Flash distillation	no effect	60–95%	no effect	50–90%
3	Electro dialysis	100% for N organic in suspension	30–50%	30–50%	40–50%
4	Inverted osmosis	60–90%	60–90%	60–90%	80–90%

* according to the initial concentration in N total of influent.

** soluble organic N, as urea or amino-acids, it is reduced substantially through the secondary treatment phase.

Untreated residual water contains less or at all nitrites or nitrates. A part of organic particles are retained by primary decantation [2, 7]. During the biological treatment, the most numerous particles containing substances based on organic nitrogen are transformed in ammonic or other organic forms. A part of ammoniac is assimilated in the biomass cells. The greatest part of N from secondary effluent is found as ammonic. In table 1 is shown the effect of different operations and treatment procedures on organic nitrogen, ammoniac and nitrates found in residual water.

2.2. Phosphorous control and removal

For most part of residual water, around 10% of P concentration corresponding to the insoluble part, is normally retained through primary decantation.

Table 7. The effects of different treatment operations and procedures on retaining phosphorous

Treatment operations or procedures		P reduction in system, %
CONVENTIONAL TREATMENT		
1	Mechanical treatment	10 – 20%
2	Activated sludge	10 – 25%
3	Bio-filters	8 – 12%
4	Biological filters with discs	8 – 12%
BIOLOGIC REDUCTION OF PHOSPHOROUS		
1	P reduction on water surface	70 – 90%
2	P reduction on sludge surface	70 – 90%
COMBINED BIOLOGIC REDUCTION OF NITROGEN AND PHOSPHOROUS		
1	Combined biologic reduction of N and P	70 – 90%
CHEMICAL REMOVAL		
1	Salt precipitation	70 – 90%
2	Lime precipitation	70 – 90%
PHYSICAL REMOVAL		
1	Filtration	20 – 50%
2	Inverted osmosis	90 – 100%
3	Adsorption on coal	10 – 30%

Exception for the quantities incorporated in the cellular tissue; in biological phase, the reduction is minimum, because P, present in residual water after primary sedimentation, is soluble. Table 7 shows the effects of conventional treatment or other treatment procedures regarding P reduction [1, 3, 4, 5].

P removal can be done through physical, chemical and biological means. Chemical precipitation (using Fe and Al salts, or lime) has already been used for P reduction. The biological treatment methods are based on simulating the microorganisms which will take more P than needed for cellular development. Lately, the development and application of biologic techniques for reducing P was preferred, instead of chemical precipitation.

When obtaining an effluent with low concentrations regarding P (generally under 1 mg/l) is necessary, filtration is used in combination with other biologic or chemical procedures. Other physical procedures, such as ultra-filtration and inverted osmosis are important in retaining P but are still applied, for removing the dissolved inorganic substances.

2.2.1. Phosphorus removal from residual waters using biological means

Lately, a special attention was paid to procedures for P removal using biological means, as alternative to chemical methods. P is retained in biological phase through incorporating procedures of orthophosphates, polyphosphates, and phosphorous linked organically in cellular tissue [1].

Total quantity of P removed is done according to the decanters produced effectively. P contained in cellular tissue is 5 times lower than N content in tissue.

According to local environment conditions, real P matter is 7 to 3 times lower than N content from cellular tissue. On average, the quantity of P removed during secondary treatment through residual sludge can vary between 10-30% from influent quantity.

By using a biologic procedure for removing P, significant results can be obtained, outside this domain.

The concept of removing P by biologic methods means exposing the microorganisms to alternative anaerobe and aerobe conditions.

Exposition to alternant conditions determines microorganisms overstressing, so that the adsorption quantity exceeds normal levels. P is used not only for survival, synthesis and energy but it is also stored and used afterwards by microorganisms.

Sludge containing p in excess is either residual or removed in the lateral treatment flux (sludge line). Alternative exposition to anaerobe and aerobe conditions can be achieved either on water surface, or in the sludge recirculation process [2].

Specific procedures of biologic treatment used for P removal are:

- A/O procedure – which implies P removal on water surface, in biologic phase;
- PHOSTRIP procedure – implies P removal on sludge surface;
- Sequential tank procedure (B.S.) – used for small quantities of residual water, on condition that is has functional flexibility, it allows retaining N and P.

A/O procedure (retaining P on water surface) [1]

A/O procedure (fig. 1) is used for retaining P combined with C oxidation from residual water. It is a biomass system in suspension „single-sludge" (a single tank, so single sludge), which combines consecutive anaerobe and aerobe areas.

For nitrification, the supply can be done by increasing the retention time needed in aerobe area. The sludge deposited is returned in the influent at the end of the tank and mixed with influent residual water.

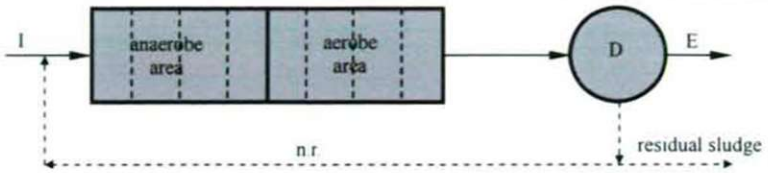

Figure 1. Technological diagram for A/O procedure:
I – influent; D – decanter; E – effluent; n.r. – recirculation sludge

Under anaerobe conditions, P contained in residual water and in the recirculated cellular mass is released as soluble phosphates. At this stage reducing partially the organic substances (as CBO_5) can be done. P is absorbed by the cellular mass in the aerobe area and is retained from fluid flow capacity into the activated sludge. P concentration in the effluent depends greatly on the ratio CBO_5 : P of residual water.

For ration higher than 10 : 1, concentrations of P soluble in the effluent under 1 mg/l can be obtained. When the ratio values are lower than 10 : 1, metallic salts should be added for obtaining low concentrations of effluent in P.

Phostrip procedure (removing P on sludge line) [1]

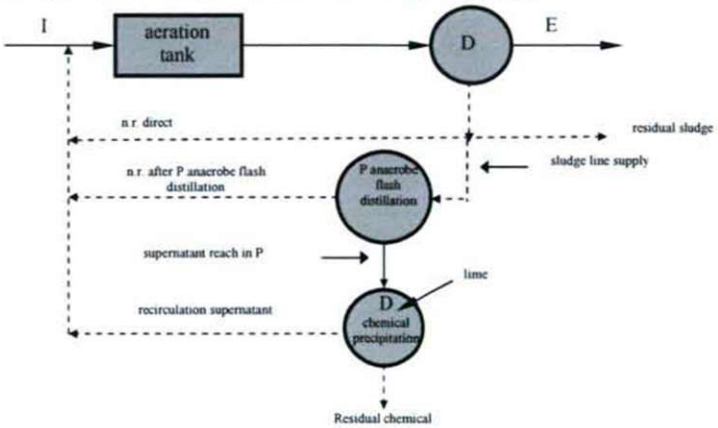

Figure 2. Technologic diagram for Phostrip procedure:
I – influent; D – decanter; E – effluent

In this procedure (fig. 2), a part of recirculated activated sludge form biologic treatment is led in an anaerobe tank for P flash distillation. The retention time in this tank generally varies between 8 and 12 hours. P is released in the flash distillation tank, it gets out of the tank as supernatant and the activate sludge poor in P is returned in the aeration tank. Supernatant reach in P is combined with lime or other coagulant in a separate tank and it is unloaded in DS or in a separate flocculation decanting tank to separate solid suspensions. P is removed from the system through chemical precipitation. PHOSTRIP type systems associated with activated sludge ones can insure an effluent with a total content of P under 1,5 mg/l, before filtration.

Procedure with sequential functioning tanks

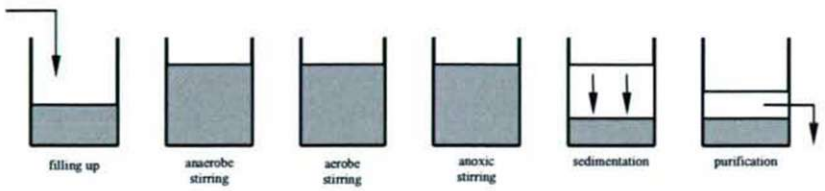

Figure 3. System with sequential loading tanks

The system (fig. 3) can operate so that it insures any combination of C oxidation with N reduction and P removal. A simple representation of this system is shown in the figure above.

3. CONCLUSIONS

Advantages and disadvantages of biologic alternatives for removing phosphorous

Below is shown a general comparison of alternative procedures for removing P using biologic means [4]. Biologic methods provide more advantages regarding the integration in the nutrients removal process in the treatment stations. Because a great part of the procedures success depends on specific local conditions, it is recommended that pilot stations tests should be performed.

A/O procedure (retaining P on water surface)

Advantages: Relatively simple functioning compared to other procedures. Residual sludge has a relatively high concentration of P 3-5% and a fertilizing value. Hydraulic retention time relatively short. In cases when only a part of P should be reduced, it can be supplemented with nitrification.

Disadvantages: It does not have the capacity to ensure separately the removal of some big quantities of N and P. Questionable performances of operation at low temperatures. It needs high values of CBO_5: P ratio. Together with minimizing the retention time of cells in the aerobe medium, a higher value of oxygen transfer might be needed. Limited flexibility in operation.

Phostrip procedure (removing P on sludge line)

Advantages: It can be incorporated in the treatment stations with existent n.a. Flexible process. P removal process is not restricted by CBO_5: P. ratio. There are many installations like this in the USA. Significant lower consumption of chemical reactives than needed for chemical precipitation in biologic phase. It can lead to orthophosphates concentrations of effluent, under 1,5mg/l.

Disadvantages: It needs lime addition for P precipitation. It needs a high concentration of O_d mixture to prevent P release in the final decanter. Cleaning the lime deposits can be considered a maintenance problem.

Procedure with sequential functioning tanks

Advantages: The process is very flexible for combining N with P removal. The process is simple. The suspensions from the mixture should not be washed in the opposite direction of hydraulic flow.

Disadvantages: Convenient only for small flows. Extra units are needed. The effluent quality depends on the decantation easiness. The design data available are limited.

Reducing these constituents can be achieved with or without chemical addition when changing the tank's functionality. P can be removed by chemical addition with coagulation reactives or biologically, without coagulation reactives addition [3]. In the configuration shown above, releasing P and reducing CBO_5 can take place during anaerobe mixing phase and reducing P in the next phase of aerobe mixing. Modifying the reaction time, nitrification or N removal can be obtained. A complete cycle total time can vary from 3 to 24 hours. In anoxic phase, a source of C as support for de-nitrification is needed, represented either by an external source, or by endogen respiration of existing biomass.

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COMPARISON OF BREADS MADE BY DIFFERENT LEAVENING TECHNOLOGIES

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ABSTRACT

Breads made with leaven and leaven substitutive products by different technologies were evaluated to find similarities and differences between the traditional making process and the industrial technologies. Volume and formal ratios of loaves, acidity degree and moisture contents of crumb, water activity and storage parameters were evaluated. Results show that the breads made with leaven with a moderately long fermentation matches to the requirements of the Hungarian Standard, but breads made with commercially available leaven substituent also showed favourable physical and chemical properties. Breads made with lactic acid showed favourable sensory properties, but low volume. Consumable times of breads were not influenced by the method of leavening. Results also proved that the most favourable result can be achieved by traditional leavening fermentation method considering sensory, physical and economical aspects.

1. INTRODUCTION

The bread is one of our much liked and most traditional foodstuff. Beside taste, nutritional value, storability, the consumer expects proper appearance and volume of bread and they depend on the properties of flour and the bread making process, the applied other additives and the microbiologic processes in the dough.

The main expectation on the microbiologic process is the high gas production, namely to produce a more gaseous dough and a more aerated bread (Arendt et al., 2007). Commonly, microbes develop the properties of dough is a mixture of natural yeasts and lactic acid bacteria (Williams and Pullen, 1998). Yeasts, mostly Saccharomices cerevisie ferments the sugars of flour into ethanol and CO_2, and as the latter one release in the dough, the developing gluten network retain it while the volume of loaf is increase. Thus, the most part of final volume of bread came from the microbial activity of yeasts (Véha and Markovics, 2010).

Not only the gas formulation is the aim of the use of microbes. Smell, acid taste and aromatic compounds are also significant microbe products of leavening and most of the aromatic compounds formed during baking, mainly as the products of lactic acid bacteria (Schieberle, 1996). Fermentation quotient, the ratio of the formed lactic and acetic acid, characterizes the aroma profile of dough and bread also, and the breads of different cultures, regions and consumer types show significant differences ((Rosenquist and Hansen, 1998). The preserving effect of leavening is also important; the formed organic acids decrease the pH of dough, thus decreases the microbial deterioration (Corsetti and Settanni, 2007).

The demands of Hungarian consumers on bread are almost unique in the world; most people prefer the product with the highest volume here and do not like the acidic taste of bread which is characteristic of leavened products. Thus, the importance of lactic acid fermentation is not significant and in the last decades direct bread making process became general, without leaven, using high amount of yeast and industrially produced leaven substituent. This product gives the acidity value for bread which is necessary for avoid microbial spoilage but do not influence the taste of product significantly. The international trends tend to more natural, tasty and healthy foods (Brummer and Lorenz, 1991) and the sourdough had a renewal worldwide. For example, sourdough is used in more than 30% of Italian bakery products and more than 200 different bread types (Ottogalli et al., 1996;

Corsetti and Settanni, 2007). These demands appeared in Hungary also and the interest in leavening bread making increased recently.

The aim of this study was to evaluate the effect of different leaving technologies on the physical and storability related properties of breads. The use of traditional leaven, lactic acid leaven and leaven substituent was examined on the volume and formal quotient of pilot breads, on the acidity value and water activity of crumb and on the storability time.

2. MATERIALS AND METHODS

Four types of test breads were made; the first one with commercially available leaven product, the second and third ones with yeast fermented leaven applied in baking industry and the third one with lactic acid leaven. The difference between the second and third type was the fermentation time; in the case of second bread the fermentation time was optimal (6 hours) but the leaven applied in the third recipe was overfermented (8 hours). The leaven size for yeast leaven was medium. Three leaven size were tried for lactic acid leaven; small (4,1% leaven for the amount of flour), medium (7% leaven for the amount of flour) and large (14,4% leaven for the amount of flour). The applied materials were BL-80 winter wheat flour, water, leaven or leaven substituent, yeast and salt. The ratios of different raw materials were experimentally determined.

Doughs were made by 2 minutes fast and six minutes slow mixing times. Resting time was 25 minutes interrupted after 15 minutes to remould. Leavening temperature was 33°C with 80% air humidity. The leavening times were 42 to 46 minutes for doughs made with leaven substituent, optimally fermented leaven and lactic acid leaven, but it was only 28 minutes for overfermented yeast, due to the higher pH acidity degree. Delivery masses were 510-515 g. Baking was performed at 250°C. Quality parameters were evaluated after the breads cooled.

The evaluated quality parameters were volume, formal ratio, acidity degree and water activity for both doughs and breads. The volume and formal ratio were determined by MSZ 6369-8:1988, acidity value according to MSZ 6369-11:1987 and water activity was evaluated by laboratory water activity measurer. Storage test was made by exterior parameters; 10 sliced breads were stored in dry cool place in closed plastic bags. Every breads were inspected and one of them were opened on every day. The appearance of the first mould brought the end of storage test.

3. RESULTS AND DISCUSSION

The use of leaven substituent and optimally fermented original leaven resulted the highest bread volumes (Table 1). The lactic acid leaven and overfermented original leaven resulted only moderate long volumes, likely due to the high acidic degree, the dominance of lactic acid bacteria and their oppressive effect on yeasts.

The formal ratio strongly depends on the flour and leaven properties, a value from 1,6 to 2,0 is the consumer's requirement. Higher values mean flat form caused by overfermentation, lack of gluten content and the quality of leaven, while lower values can be observed short leavening time, strong gluten and leaven properties. Results show that the formal ratios of breads made with original overfermented and lactic acid leavens were appropriate. A projecting value can be seen for bread made with medium lactic acid leaven. The overfermented original leaven also made the dough hard as well as the leaven substituent and the maybe due to the too acidic conditions the product became small.

Table 1. Quality parameters of breads made with different leavening methods

	Leaven substituent	Original leaven		Lactic acid leaven		
		optimal fermentation time	over-fermented	small	medium	large
Bread volume, cm^3	2436	2466	1875	1474	1659	1836
Formal Ratio	1,56	1,62	1,57	1,67	1,87	1,68
Acidity value, SH°	3,69	4,09	4,45	2,66	3,31	4,13
Moisture content of crumb, %	44,03	43,55	43,69	44,60	44,00	44,81

The acidity degree of breads must be between 3 and 5 SH° concerning the requirements of the Codex Alimentarius Hungaricus. Only the bread with small amount of lactic acid addition did not met this demand with its value of 2,66 SH°, the low amount of added leaven resulted lack in aromatic compounds. The highest values was found in breads made with large amount of lactic acid leaven and with overfermented original leaven.
The moisture content of breads influences its structure, crumbling and storability. In our experiment the causes of differences in bread crumb moisture contents were the leaven and added water contents of different breads. Breads made with original leaven showed the lowest crumb moisture contents and the ones made with lactic acid leaven showed the highest values.

The changes in water activity were measured until the first mould appeared. It can be seen in Figure 1 that similar trends were found in the case of the breads; the values were recorded in a narrow region and an increase was followed by a decrease after 4 to 6 days. The absolute values were similar for the different breads, and it seemed that the water activity did not influenced the storability; the breads made with leaven substituent and original leaven kept their microbiological suitability 8 days long, but the ones made with lactic acid leaven only 7 days long.

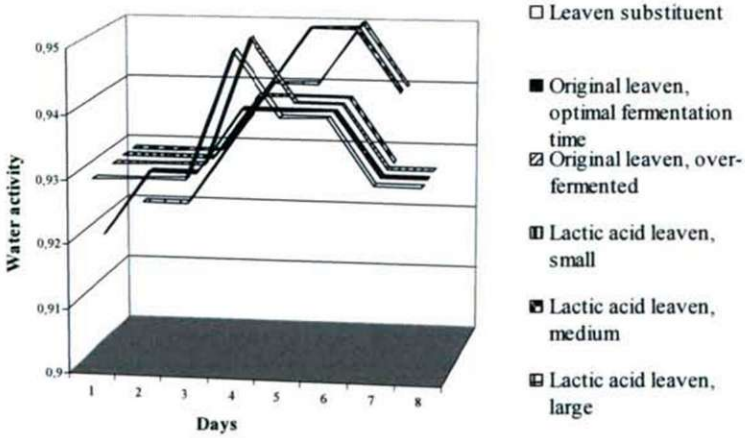

Figure 1. Changes in water activity of bread slices during storage

4. CONCLUSIONS

Our results prove that lactic acid leaven is suitable for high quality bread making. Although the volume of these breads are slightly lover than the ones made with leaven substituent or traditional leaven, the formal ratios were more favourable of them. The appearance of the product is one of the main selection criteria of consumers during purchasing, but nowadays it is not sure that the highest volumes breads are the most preferred ones, due to the wide-ranging offer of flour additives which give better appearance of product but influences negatively the other sensory and storage properties. The better formal ratios, the more natural appearance are well received more in several cases. The volumes of breads made with lactic acid leaven may be increased with more yeast addition.

Results in lactic acid leaven addition on the acidity value and the storability showed that these breads fit for the Hungarian requirements, except the one made with low leaven addition. Notwithstanding, probably due to the less added leaven, the storability of the breads made with lactic acid leaven was slightly shorter than the ones of other breads but it met the consumers' demands. Considering the results, the best performance was shown by the bread made with original leaven, but the ones made with lactic acid can be a way of the selection enlargement of bakery products and may bring new tastes and products into the market.

ACKNOWLEDGEMENTS

The work is supported by the TÁMOP 4.2.1./B-09/1/KONV-2010-0007 project. The project is implemented through the New Hungary Development Plan, co-financed by the European Social Fund and the European Regional Development Fund.

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ANALYSIS OF BIOTIC PARAMETERS OF FLOODPLAIN FORESTS FRAGMENTS IN THE AGRICULTURAL LANDSCAPE OF THE LOWER VÁH RIVER

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ABSTRACT

We identify only fragments of the original floodplain forests on agricultural land in the alluvium of the lower Váh river. The reason of their elimination is based on the history, particularly because of agricultural land and hydrological modification of rivers. We evaluated biotic parameters of the floodplain forests fragments (life forms, diversity of vegetation, seasonality of leaves and flowering time) in the area of Čalovec and Ďulov Dvor. As for structural changes of vegetation in these areas, we can conclude that there was a difference in the range of species, in the Ďulov Dvor locality hydrophilic population absent and invasive and potentially invasive species are more present (especially at Ďulov Dvor locality). Analysis of biotic parameters of vegetation is part of a complete evaluation of fragments of floodplain forests (including abiotic parameters) aimed to restore their original function in the country.

1. INTRODUCTION

Fragments of floodplain communities represent non-forest woody vegetation in the surrounding agricultural land. The dynamics of alluvial floodplain communities is strongly influenced by water regime (Figure 1). Their species structure is diversified by at least one of the factors of floodplain dynamics – the influence of surface flooding or ground water.

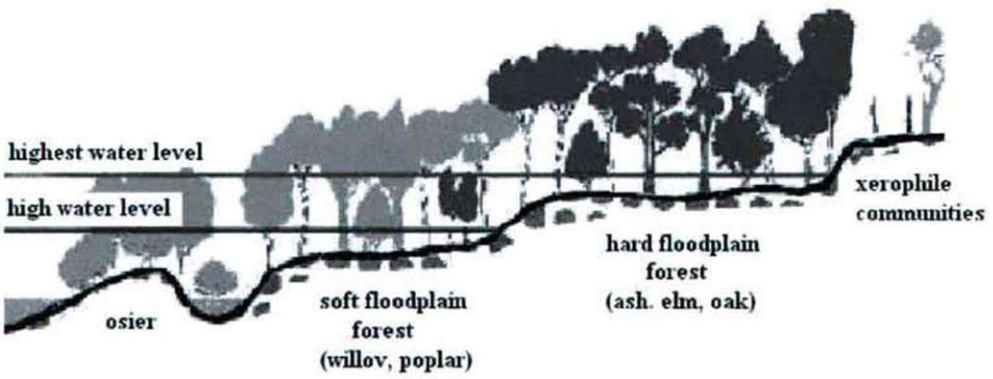


Figure 1. Scheme of alluvial communities' structure

A survey of river habitats and alluvial biotopes of lowland rivers shows a continuous transition by habitats – from the water habitats in the main river, across habitats in varying degrees affected by water to terrestrial habitats (Kotrla, 2005). A smooth change of type's plants from hydrophytes through hygrophytes to terrestrial mezophytes is typical for this

transition. As mentioned in Šimonovič, Šimonovičová (1999), Tepley et al. (2004), floodplain communities of riparian zone provide a unique combination of high species diversity, high density and high productivity.
Vegetation character inform about the degree of anthropogenic impact, it indicates abiotic and soil conditions, water regime and microclimate. Feranec, Oťahel (2003) say, that vegetation is an important indicator of eco-stabilizing solution and socio-economic function in the country.

Woody plants, as edificatory of floodplain forest communities, are the key indicator species of terrestrial and ecotone alluvial habitats (Buček et al., 2004). Status and evolution of woody plants populations and communities is an indicator of not only natural processes but also socio-economic processes in present country. In the distribution of living organisms also climate plays an important role. The climate is decisive for the habitat to which they are bound and on which they depend. Climate changes, which occurred in recent years, bring changes in the distribution of species and consequently change in vegetation type (Davis, 1986).

Floodplain forests are one of the most affected wetlands in Slovakia. According to Vološčuk, Šíbl (2001) thousands of hectares of floodplain forests in the alluvium of our larger rivers were flooded in the dam reservoir, destroyed in the construction of protective levees and other water facilities, additional thousands of hectares have been negatively affected by elimination of flooding and decrease of ground water level. At present time, floodplain forests are most threatened by the construction of water projects and stream regulations. Other threat for floodplain forests is the penetration of non-native, aggressive plant species. This ecologically unfavourable situation leads to the need for restoration of the wetlands ecosystems in the agriculture landscape i.e. to increase area where natural fluvial processes with natural biota can be restored.

The significance of the vegetation has two sides. It highlights the company's interests and its individual members and also reflects natural conditions, where vegetation grows and operates.

2. RESEARCH STANDS

We selected two sides of floodplain forests fragments on agriculture land of lower Váh river, localities Čalovec and Ďulov Dvor.
Čalovec site – Near of the village Čalovec, GPS localization 47° 48' 41" N and 18° 0' 11" E, area 13794 m^2.
Ďulov Dvor site – Near of the town Komárno, part Ďulov Dvor – Zámocká pustatina, GPS localization 47° 47' 23" N and 18° 8' 33" E, area 48020 m^2.
Selected characteristics of the research stands: average year air temperature / temperature in growing season 11.0 °C / 15.7 °C, average annual sum of precipitation / in growing season 520.28 mm / 358.76 mm, soils Calcaric Fluvisols, syntaxonomical structure *Salici–Populetum fac.* Fraxinetosum (Ďulov Dvor) and *Salici–Populetum* typicum (Čalovec), height of underground water level 2.20 m (Ďulov Dvor) and 1.82 m (Čalovec).

3. MATERIAL AND METHODS

In addition to abiotic environmental analysis, detailed analysis of biotic parameters is required in order to realize any human activity aimed at protection or restoration of degraded ecosystems. Were evaluated following biotic parameters:

Life forms – determined by Raunkaier (1934), interpreted by Jurko (1990), Ellenberg et al. (1992), which are biological types with regard to the location of the renewal buds during adverse periods.

In assessment of life forms we consider the relative proportions of annual, biennial, perennial plants and woody plants as the average of all vegetation levels. Margin of life forms is: hydrophytes, one and two terophytes, hemicryptophytes, geophytes, herbaceous and woody plants chamaephytes and shrub and tree phanerophytes. Analysis of living forms is the easiest analysis of plant community, it is a quantitative approach to record of plant community and provides more information than a list of species. The composition of life forms reflects habitat conditions in the growth, use of the space and relations between plant populations. The results were expressed graphically as a spectrum of life forms.

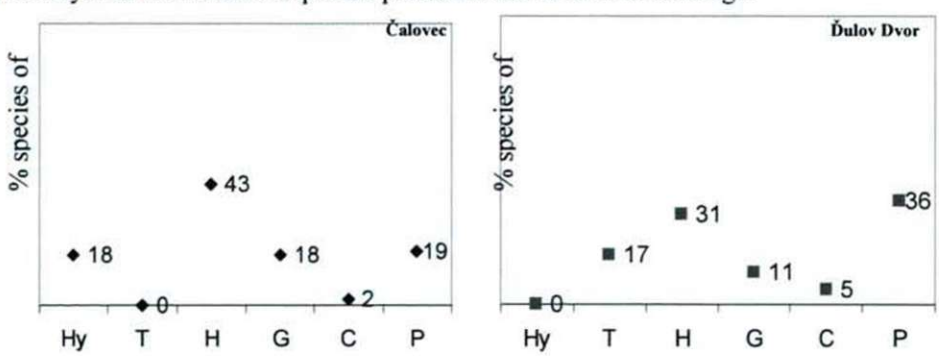
Diversity of vegetation – We evaluated the taxonomic diversity, which is mainly influenced by the particular ecological quality of habitat. The habitat provides conditions and enables to fulfil demands of each species for provided resources. Diversity of vegetation at research sides were processed by Jureková et al. (2008).

Seasonality of leaves has a special importance for the production of metabolism and the competitiveness of species. We monitored time of buds and time of defoliation.

Flowering time – It is a different phonological stages of flowering. We surveyed the beginning of flowering to full bloom. Time categories of flowering were determined by Dierschke (1983).

4. RESULTS AND DISCUSSIONS

In the forest phytocenose we can distinguish functional groups of plants according to each floor – tree, brush and herbaceous ground-floor. The basic of these classifications are growth, respectively life forms of plants. At Čalovec site hemicryptophytes predominated (43 % species of plants) – *Caltha palustris, Carex acuta, Galium palustre, Lysimachia vulgaris, Lythrum salicaria, Mentha aquatica, Scutellaria galericulata, Solidago gigantea, Teucrium scordium*, with an increased proportion of phanerophytes (19 % species of plants) – *Populus × canescens, Salix alba, Salix cinerea, Salix fragilis*, identified by species composition. At the drier site Ďulov Dvor predominated phanerophytes (36 % species of plants): *Crataegus monogyna, Euonymus europaeus, Frangula alnus, Fraxinus angustifolia, Negundo aceroides, Populus × canescens, Prunus cerasifera, Prunus spinosa, Rhamnus catharticus, Robinia pseudoacacia, Salix alba, Salix fragilis, Sambucus nigra, Swida sanguinea, Viburnum opulus.* A high proportion is also hemicryptophytes – 31 % species of plants (Figure 2). Tree and shrub layer of the herbal component predominated in term of coverage.

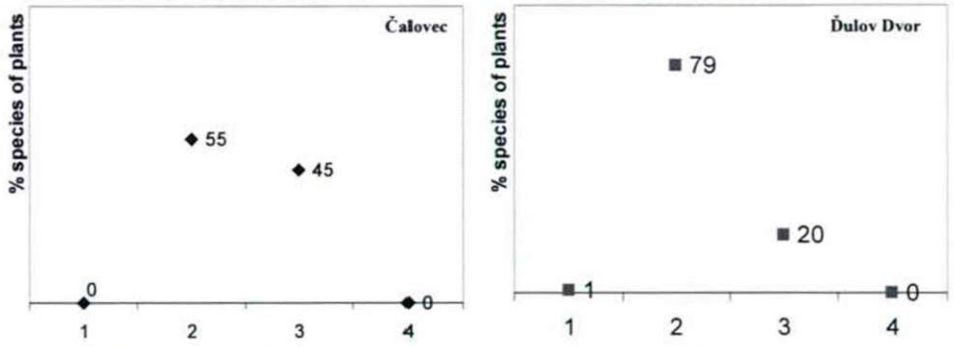


Legend: Hy – hydrophyte, T – terophyte, H – hemicryptophyte, G – geophyte, C – chamaephyte, F – phanerophyte

Figure 2. Spectrum of life forms of plants at research sites

At research sites, we followed the method of reproduction of dominant woody plant species (phanerophytes – *Salix alba* and *Populus* × *canescens*). Vegetative or generative methods are method of reproduction of woody plants. We can say that there exists the dominance of vegetative propagation method for phanerophytes at researched locations - breeding sprouts. The reason can be the fact that seedlings of phanerophytes have hibernated organs at low altitude (in contrast with adults) and they have a short root system. Therefore, they are exposed to adverse temperature conditions during winter and lack of water due to fluctuations in ground water levels during the growing season. High mortality in the regeneration of dominant woody plants may be in addition to fluctuations in groundwater levels and low temperatures caused by the improper light ratios in the dense tree crown cover. Paganová, Jureková, Merganič (2009) confirmed death of seedlings of dominant woody plants in floodplain forest at research sites.

In another experimental research we have seen the seasonality leaves and flowering time. Data on seasonality leaves, the period since the creation of buds until defoliation are shown in the Figure 3. On the sites dominated aestivalen permanence of leaves, leaves are green in summer, (55% of species at Čalovec and 75% of species at Ďulov Dvor), respectively the leaves are green during all summer, or at least until the middle of summer.

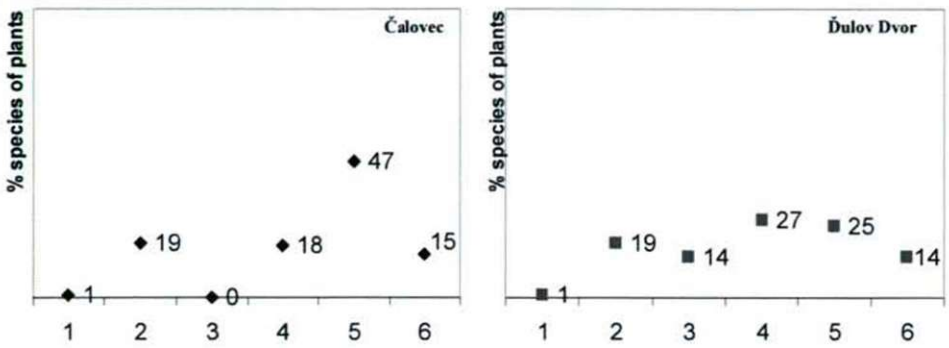


Legend: 1 – green only in spring; 2 – in summer they are green; 3 – hibernate; 4 – evergreen

Figure 3. Seasonality of the leaves at research sites

The most sensitive period for determination of the existence of borders and the spread of species (Thieneman rule) is a period of juvenility and flowering. We determined the phenological stages of flowering also in our experimental work. The results are shown in the Figure 4. At the site Čalovec 47% of species bloom in summer time (the period of full summer - the third decade of June till the second decade of August), respectively on this site 19% of species blooms in early spring period (3rd decade of March till the first decade of May). At site Ďulov Dvor 27% of plant species bloom in late spring (3rd decade of May to the second decade of July) and 25% during the full summer. We conclude that the top life cycle of plants is during the growing season in July and August on both sites.

In terms of taxonomic diversity of sites we observed greater species diversity on drier habitat (Ďulov Dvor) - 42 plants species, and at Čalovec site we identified 23 plants species. Possibility of plant species used habitat conditions determines taxonomic diversity. Particularly the possibilities of plants fulfill their demands on natural resources. We observed difference of plant species on the research sites as a result of difference ground water level and water regime in studied years. It is a natural phenomenon of inundation.



Legend: 1 – end of winter; 2 – early spring; 3 – full of spring; 4 – end of spring; 5 – full summer; 6 – late summer; 7 – autumn

Figure 4. Time of flowering plants at research sites

Ďulov Dvor site (42 species of plant): *Agropyron repens, Agrostis stolonifera, Aster lanceolatus, Atriplex patula, Bryonia alba, Calamagrostis epigejos, Carex acuta, Cirsium arvense, Clematis vitalba, Crataegus monogyna, Cucubalus baccifer, Epipactis helleborine, Epipactis tallosii, Euonymus europaeus, Fallopia dumetorum, Frangula alnus, Fraxinus angustifolia, Galeopsis pubescens, Galinsoga parviflora, Galium aparine, Geranium robertianum, Glechoma hederacea, Humulus lupulus, Iris pseudacorus, Negundo aceroides, Populus × canescens, Prunus cerasifera, Prunus spinosa, Rhamnus catharticus, Robinia pseudoacacia, Rubus caesius, Salix alba, Salix fragilis, Sambucus nigra, Swida sanguinea, Symphytum officinale, Torilis japonica, Urtica dioica, Viburnum opulus, Vicia cracca, Viola hirta, Viola odorata*

Čalovec site (23 species of plant): *Berula erecta, Caltha palustris, Calystegia sepium, Carex acuta, Carex riparia, Galium palustre, Glyceria maxima, Iris pseudacorus, Lycopus europaeus, Lysimachia vulgaris, Lythrum salicaria, Mentha aquatica, Phragmites australis, Populus × canescens, Salix alba, Salix cinerea, Salix fragilis, Scutellaria galericulata, Solanum dulcamara, Solidago gigantea, Stachys palustris, Teucrium scordium, Tithymalus palustris*

From the structural changes of vegetation at the research sites we can conclude a difference in the species range. At the Ďulov Dvor site hydrophilic population absent and invasive or potentially invasive species are more present. The impact of ruderal taxa starts in direct contact phytocoenosis of the intensive cultivated fields (*Cirsium arvense, Solidago canadensis, Galinsonga parviflora* – 12 species). The invasive species are *Negundo aceroides*, potentially invasive are species: *Cirsium arvense, Prunus cerassifera, Bryonia alba, Robinia pseudaccacia*, which may affect negatively the further development of vegetation on the both studied localities.

5. CONCLUSIONS

Today, floodplain forests vegetation creates only a small part of floodplain forest vegetation of the past and they are usually present only in small fragments in shallow depressions.

At present floodplain forests are included to wetland communities. They belong to one of the most endangered ecosystems not only in Slovakia, but throughout Europe.

Abiotic factors (ground water level, physiological drought, heavy metal content) were variable during the period of research, and according to our assumptions they could cause

physiological adaptation of the herb and tree vegetation components in given conditions (Kotrla, Prčík, 2010).

For quantification the structure of plant communities, we have confirmed the different representation of life forms of plants, depending on humidity habitat. At Čalovec site predominated hemicryptophytes (43% of plant species) and at Ďulov Dvor site phanerophytes (36% of plant species) predominated. At Ďulov Dvor site predominated shrub and tree the floor level above herb. The method of plants reproduction is mainly vegetative. Seedlings of woody plants are after germination limited in growth by a lack of water and they are subordinate to competition. At Ďulov Dvor site is limited population of hydrophilic, wetland and aquatic plant species. At Čalovec site, where is a higher ground water level, stored the population hydrophilic species of herbs and grasses.

From experimental research of floodplain forests communities in alluvium of the lower Váh river, we can identify degradation factors decisive in their life processes: anthropogenic impacts related to agriculture around fragments of floodplain forests, changes in hydrological regime caused by changes in the dynamics of groundwater level, microclimatic effects such as a lack of rainfall, especially during the growing season, respectively physiological drought resulting from a precipitation and air temperature, non-native invasive and potentially invasive species.

After a detailed analysis of abiotic and biotic indicators fragments of floodplain forests in lowland agricultural landscapes we can start to restore these habitats in response to disturbance factors. The aim of the process of restoration of wetland habitats in intensively used agricultural land is the increase of their natural functions from the ecological, through environment to the socio-economic functions.

ACKNOWLEDGMENT

This work was supported by VEGA under the contract 1/1220/12 Modelling growth of energy plants grown in climatic conditions of southern Slovakia.

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SCIENCE AND EDUCATION AT THE FACULTY OF TRANSPORT (SUT)

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ABSTRACT

The studies in the field of transport began at the Silesian University of Technology in 1969. Originally, they were carried out in Transport and Communication Unit of Mechanical and Power Engineering Faculty. In 1974 the Institute of Transport and Communication, operating as a faculty, was established. In 1984 the Institute of Transport was organized. In 1992 the University structure was reorganized which resulted in combining the Institute with the Faculty of Materials Science, Metallurgy, Transport and Management that was newly established in Katowice.

1. INTRODUCTION

Due to the fast development of teaching and scientific base as well as enlarging number of teaching staff, on the 1st of September 2002 the Institute of Transport was turned into the Faculty of Transport following the resolution of the Senate.
Thus 2009/2010 academic year is anniversary for faculty. A number of anniversary actions has been devoted this event. On fig. 1 a number of photos made during ceremonial meeting are shown.

Figure 1. Ceremonial meeting devoted to 40-year-old anniversary of faculty: a) Speech of the pro-rector of SUT L. Blacha; Congratulations from the vice-mayor of Katowice K. Siejna; c) Anniversary concert; d) Participants of the meeting

Recently there was a considerable development of pedagogical, scientific base of faculty, and also increase in number of its personnel structure. It has allowed to expand a number of teaching disciplines at the faculty, and also to increase possibilities of the enrolment of students. Besides the basic faculty which is in Katowice, in 2000 its branch in Tychy was opened and in 2002 the faculty branch in Bytom started to function. In this time 25 postgraduate students work over the termination of their doctoral thesis. More than 6000 students have graduated from the Faculty so far.

Personnel structure of the Faculty is presented bellow.

-Professors	17
-Docents	3
-Doctors	56
-Other pedagogical employees	1
-Engineer and technical workers	5
-Administrative workers	23

Council of Faculty has the right of assignment of a scientific degree of PhD on a discipline „Construction and maintenance of machines". The Faculty possesses Polish and foreign certificates for official certification tests of automotive vehicles adapted for gas fuels (LPG, CNG). The Faculty is also entitled to conduct certification tests of machines and vehicles being in operation in Polish railway transport.

2. EDUCATION

During its 40 years long activity a model of education of a transport engineer has been elaborated and is constantly under modernization. This model meets restrictive requirements which characterize modern transport professionals. The education at the Faculty of Transport is available by full-time and part-time courses.
Organization of full-time study is presented bellow.

- engineer study; I -VII semester,
- master study; VIII -X semester

These studies consist of two degrees. The first four semesters of the common plan of studies for the whole course and for both types of studies (I and II degree) shall comprise of nontechnical subjects, basic subjects and technical course subjects. After having completed the fourth semester, the students are to choose their specialty.
Specialty to choose by students:

- Operating and Maintenance of Automotive Vehicles
- Technique and Management in Automotive Transport
- Operating and Maintenance of Rail Vehicles
- Mechanical Handling
- Logistic of Transport
- Traffic Engineering
- Air Navigation
- Informatics Systems of Transport
- Mechanics and Exploitation of Air Transport

During the seventh semester students are to prepare an engineer diploma work.

The II degree studies are continued on three successive semesters (VIII-X). The schedule of the II degree studies includes non-technical subjects (foreign language), basic subjects (mathematics and physics), technical course subjects and specialty subjects. During the tenth semester students are preparing a master degree work and they participate simultaneously in seminar courses. After the ninth semester, a diploma practice lasting 4 weeks shall be applied.

Students of faculty take part in research works. For example, degree work of the graduate of the department of logistics and mechanical handling mgr Adam Furich has received concern FIAT award.

Study program is presented below:

1. Engineers subjects volume [hours]:
   - General : 300,
   - Basic : 570,
   - Technical : 1035,
   - Specialization: 495,
   - Total: 2400.
2. Masters subjects volume [hours]:
   - General: 90,
   - Technical: 225,
   - Specialization: 585,
   - Total: 900.

Organization part-time study is the following:

- engineer study; I-VIII semester,
- master study; IX-XII semester.

Study program of part-time study is the same like on full-time study, but learning process is carried in 60% on the faculty and in 40%home by the students. The registration of students' progress in learning is carried with the use of pointing system (ECSP - European Credit System Points). Point-based system rules:

- basic rules are common for all stationary and non-stationary studies
- system ECTS (European Credit Transfer System) final point amount:
  - for 1st level studies 210 ECTS (at least 26 per semester)
  - for 2nd level studies 90 ECTS (at least 22 per semester)
- calculation period is equal to one semester
- prerequisites for registering at next calculation period:
  - at least 80% of required points gained during each of previous periods
  - finalizing all obligatory activities and other duties with no longer than 1 year delay

Figure 2. Student's scientific session

The education on the Faculty of Transport is available on Post-graduate studies (2 semesters long). These are the following:

- Logistics of transport
- Computer aid design, manufacturing and exploration of vehicles
- Modern control systems of a railway traffic and certification of equipment
- Reconstruction of road accidents
- Quality management and environment on transport
- The organization of civil aviation in EU
- Techniques and organization of railway transport in EU
- The integrated system of safety on a railway transportation
- Safety of traffic
- Diagnostics of cars
- Technical expert appraisals of cars
- The integrated control systems on transport

3. INTERNATIONAL COOPERATION

The faculty has signed contracts on the academic cooperation with a number of foreign universities:

1. Pryazovskyi State Technical University, Institute of Mechanics and Transport, Mariupol (Ukraine);
2. Donetsk Institute of Automobile Transport (Ukraine);
3. Technical University of Ostrava, Faculty of Mechanical Engineering (Czech Republic);
4. University of Zagreb, Faculty of Transport and Traffic Sciences (Croatia);
5. Riga Technical University (Latvia);
6. East Ukrainian National University named after V. Dal, Lugansk (Ukraine);
7. Petersburg State Transport University (Russian Federation);
8. Kazakh Automobile - Road Academy named after L.B. Goncharov, Almaty (Kazakhstan);
9. Kazakh National Technical University named after K.I.Satbaev, Almaty (Kazakhstan);
10. Kama State Academy of Engineering and Economic, Naberezhnye Chelny (Russian Federation).

There is also an intensive exchange of students and teachers within the limits of the program LLP-Erasmus. The faculty has acted as the initiator of signing of contracts with following universities:

- Karel de Grote-Hogeschool (Belgium)
- VŠB – Technical University of Ostrava (Czech Republic)
- Czech Technical University in Prague (Czech Republic)
- Cologne University of Applied Sciences (Germany)
- ESIGETEL - École Supérieure d'Ingénieurs en Informatique et Génie des Télécommunications (France)
- Technological Education Institute of Piraeus (Greece)
- University of Szeged (Hungary)
- Vilnius University of Applied Engineering Sciences (Lithuania)
- The University of Beira Interior (Portugal)
- Vocational College of Traffic and Transport Maribor (Slovenia)
- Technical University of Košice (Slovakia)
- University of Žilina (Slovakia)
- University of Zagreb; Faculty of Transport and Traffic Sciences (Croatia)
- University of Pardubice; Jan Perner Transport Faculty (Czech Republic)
- Cranfield University (United Kingdom)
- The University of Architecture, Civil Engineering and Geodesy (UACEG) in Sofia (Bulgaria)

a

b

c

Figure 3. 2nd International Scientific Conference "Transport Problems": a) The vice-mayor of Katowice J. Kocurek welcomes participants of conference; b) Presentation of dr. Marinov (Newcastle University); c) Participants of conference in Krakow (Wawel)

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ANALYSIS OF PARAMETERS AFFECTING THE SHELF LIFE OF LIQUID WHOLE EGG

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ABSTRACT

In our measurements we tested the changes in viable cell count in liquid whole eggs. Central complex rotation design was used in planning our experiments, and response surface method (RSM) was applied to analyze the effect of each parameter (pH, storage temperature, storage time and preservative content) on the viable cell count.
Based on our measurements, in addition to the storage time, the pH value and storage temperature of liquid egg samples significantly affect ($p<0.01$) the viable cell count, but any inhibitory effect of preservatives (Na benzoate, K sorbate mixture) on microbial growth could not be clearly detected. Using the secondary polynomial model which was adjusted to our data, the measurements were defined very well; therefore it is hoped that our results will afford real help in estimation of the microbiological condition of liquid whole egg products which are preserved by various methods.

1. INTRODUCTION

The shelf life of liquid eggs is relatively short since the proteins responsible for microbial resistance of shell egg is denatured during pasteurization (Baron et al., 1999), and in case of the mixture of white and yoke of egg provides a medium of excellent composition for microbial growth. Therefore, liquid egg production plants use various preservatives to increase the shelf life of their products. Such substances include citric acid and other additives according to the Hungarian Codex Alimentarius that approves these products such as sodium benzoate and potassium sorbate. The total concentration of the two substances together can be up to 5000mg/l.

In the selection of the amount of citric acid the pH sensitive proteins of egg represent the main limitation; these proteins are denatured at a relatively high rate at the pH lower than 5. However, the adjusted acidity highly effects on the efficiency of the preservatives that can be used in liquid egg products. But potassium sorbate and sodium benzoate do not have appropriate effect at nearly neutral pH values (Marín et al. 2003).

Sodium benzoate and potassium sorbate can be added to liquid egg products at any portions up to a concentration of 5000 mg/l (one of them can even be omitted); while the experiments with foods prepared from egg showed that they can reduce microbial growth significantly only in combinations (Wind és Restaino 1995).

However, it should be noted that in addition to correct selection of preservatives, adequate storage temperature and microbial contamination and composition of the fresh product from the production line also significantly effect on the shelf life of products.
Our purpose with this work was to determine how the total live germ count changes in liquid whole eggs during storage in refrigerator depending on the storage temperature, pH value of samples and their preservative content.

2. MATERIALS AND METHODS

The liquid egg white samples ($pH=7.1\pm0.1$) were obtained for this experiment from a Hungarian egg processing plant. Samples were raw liquid egg samples without heat treatment. Liquid egg samples were obtained from the production line in the evening before the

experiment, and were stored for maximum 24 hours at 4 °C in a refrigerator until starting the tests.

The pH value of samples was adjusted with citric acid, and we used a mixture of sodium benzoate and potassium sorbate in 1:1 ratio as preservative. After the adjustment of pH and preservative content the baseline of total live germ count (N_0) of all samples was measured and found to be nearly similar, approximately 2.68×10^3 ($\lg N_0 = 2.43 \pm 0.19$). After adjustment of the values the samples were stored at 4 to10°C in a refrigerator in accordance with the test requirements.

The central complex rotation design (CCRD) (Box and Draper 1987) was used for the tests. The response surface method (RSM) was applied to analyze the effect of each variable (pH, storage temperature, storage time and preservative content) on the increase of the live germ count. Tables 1 and 2 show the design of the experiment and the factor levels. The main advantage of this experimental approach is that the number of the tests to be performed decreased. However, sufficient information was available for acceptable statistically results. We used the response surface method for approximation with polynomial model of second order. Experiments were conducted in random order and data were analyzed by a software (Unscrambler v 9.1 (CAMO PROCESS AS, OSLO, Norway). In the general form of the second order polynomial model used in this study there were three X variables:

$$Y = \beta_{11} + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_{11} \cdot X_1^2 + \beta_{22} X_2^2 + \beta_{33} X_3^2 + \beta_{44} \cdot X_4^4$$
$$+ \beta_{12} \cdot X_1 \cdot X_2 + \beta_{13} \cdot X_1 \cdot X_3 + \beta_{14} \cdot X_1 X_4 + \beta_{23} \cdot X_2 \cdot X_3 + \beta_{24} \cdot X_2 \cdot X_4 + \beta_{34} \cdot X_3 \cdot X_4$$

that provide with linear X_1, X_2, X_3, X_4 expressions and quadratic X_1^2, X_2^2, X_3^2, X_4^2 expressions. X_1 variable represents the pH adjusted with citric acid, X_2 represents the preservative concentration, X_3 represents the storage temperature, and X_4 represents the storage time. Y is the independent variable to be determined by the model (change in live germ count). β_1, β_2, β_3, β_{11}, β_{22}, β_{33}, β_{12}, β_{13}, β_{23} expressions are the regression coefficients of the model (Table 3).

Table 1. Trial design and factor levels in encoded values

	Encoded factor	-1.682	-1	0	1	1.682
pH	X1	4.0	4.5	5.0	5.5	6.0
Preservative concentration, mg/kg	X2	0.0	0.1	0.3	0.5	0.7
Storage temperature, °C	X3	4	6	8	10	12
Storage time, day	X4	1	4	7	10	13

Testing viable cell count

1 gram of liquid egg samples were homogenized by continuous stirring and were diluted with sterile water for testing the viable cell count. From these test samples $1.0 - 10^{-8}$ g quantities (approximately tenfold of the usual dilution) were transferred into meat liquid agar medium by covered plate pouring technique. The prepared samples were incubated at 30 °C for 24 hours and the characteristic colonies grown were counted for each Petri dish (according to the standard). The colony counting was always performed with 3 samples. Dishes having less than 30 colonies were not included in the evaluation of results.

3. RESULTS AND DISCUSSION

The change of microbial count in samples treated and stored variously is shown in Table 2. The effect of the different variables on the viable cell count can be observed even without analysis of the model. For example in cases when the different tests were varied only in the pH adjustment (storage time 7 days at 8 °C with addition of 0.3 g/kg preservative), we observed differences of around 6 orders of magnitude between the samples adjusted to pH=5.0 and pH=6.0 (Test 2 and Test 26).

Considerable differences were found with storage at different temperatures after storage for 7 days in terms of the change in viable cell count in samples stored at the lowest (4 °C) and at the highest (12 °C) temperatures. In this case, we measured a difference of around 8 orders of magnitude between the results of Test 5 and Test 6.

We did not find significant differences between the results when the quantity of the preservatives was added according to upper and lower limits (Tests 3 and 4). After 7 days of storage of samples having higher pH than 5.0, an increase in viable cell count of 1.69±0.20 orders of magnitude was observed in samples stored at 8 °C without added preservative, while the increase of 1.60±0.32 orders of magnitude was observed with 0.7 g/kg preservative concentration. We did not observe significant antimicrobial effect of the preservatives added to liquid egg even at lower pH values (pH=4,0-4,5). In Tests 21 and 23 we did not find any difference between samples containing the preservatives at 0.1 or 0.5 g/kg concentration after storage when the pH was 4.5, the temperature 10 °C and storage tome 10 days.

Table 2. Trial design and factor levels (%) in actual values and test

Test no.	pH	Preservative concentration, g/kg	Storage temperature, °C	Storage time, day	$Lg(N/N_0)$
1	4	0.3	8	7	0.05±0.01
2	6	0.3	8	7	7.52±0.38
3	5	0.0	8	7	1.69±0.20
4	5	0.7	8	7	1.60±0.32
5	5	0.3	4	7	0.24±0.09
6	5	0.3	12	7	8.26±0.42
7	5	0.3	8	1	0.24±0.14
8	5	0.3	8	13	3.02±0.55
9	4.5	0.1	6	4	0.14±0.07
10	5.5	0.1	6	4	0.79±0.19
11	4.5	0.5	6	4	0.60±0.09
12	5.5	0.5	6	4	0.77±0.13
13	4.5	0.1	10	4	0.70±0.25
14	5.5	0.1	10	4	2.79±0.34
15	4.5	0.5	10	4	0.66±0.09
16	5.5	0.5	10	4	6.36±0.54
17	4.5	0.1	6	10	0.36±0.05
18	5.5	0.1	6	10	1.98±0.23
19	4.5	0.5	6	10	0.14±0.05
20	5.5	0.5	6	10	1.95±0.13
21	4.5	0.1	10	10	1.76±0.24
22	5.5	0.1	10	10	5.87±0.61
23	4.5	0.5	10	10	1.66±0.26
24	5.5	0.5	10	10	8.12±0.54
25, 26, 27	5	0.3	8	7	1.64±0.11

N_0 – baseline total viable cell count
N – total viable cell count measured in the test

Table 3. Regression coefficients of the secondary polynomial model for response analysis with encoded units (* significant effect demonstrated)

	B-coefficients	MS	F-ratio	p-value
Intercept	1.657	8.24	10.34	0.01*
pH(A)	3.13	58.77	73.74	0.00*
preservative(B)	1.18	1.34	1.68	0.22
storage temperature(°C)	0.775	57.65	72.33	0.00*
storage period(D)	0.203	8.86	11.11	0.01*
AB	0.328	2.02	2.53	0.14
AC	0.814	12.45	15.62	0.00*
AD	0.311	1.81	2.27	0.16
BC	0.317	1.89	2.37	0.15
BD	-0.12	0.27	0.35	0.57
CD	0.276	1.40	1.79	0.21
AA	0.389	3.78	4.75	0.05*
BB	-0.105	0.28	0.35	0.57
CC	0.497	6.188	7.763	0.02*
DD	-0.109	0.295	0.37	0.55

The storage time had significant effected on the changes in the viable cell count. After storage for 1 and 13 days (as the upper and lower limits) under similar conditions (pH=5, 8 °C, 0.3 g/kg preservative) applied to test this we measured a difference of around 2.5-3 orders of magnitude in the change in viable cell count (Tests 7 and 8).

There is a close correlation($r=0.97$) between predicted and measured $\lg(N/N_0)$ when taking into account the effect of the four variables. Therefore, there is a close correlation between the predicted and measured viable cell count in liquid egg samples.

4. CONCLUSIONS

In general pH and storage temperature of liquid eggs significantly affects the change in viable cell count during storage. However, our measurements did not clearly demonstrate that the mixture of Na benzoate and K sorbate added to liquid egg at the approved concentration range would significantly inhibit microbial growth.

We introduced storage time into our experiments as the fourth variable. This we could obtain a model closely correlated with our results ($r^2=0.97$) by which the storage time to a specific increase in viable cell count in various liquid whole egg products can be calculated with good approximation.

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CHANGES IN NUTRITIVE QUALITY OF OSMODEHYDRATED PORK MEAT IN SUGAR BEET MOLASSES

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ABSTRACT

The aim of this study was to examine effects of sugar beet molasses as hypertonic solution during osmotic dehydration on nutritional properties of pork meat. Samples of pork meat were dehydrated in sugar beet molasses as an osmotic agent during 5 hours, at room temperature of 22°C and atmospheric pressure. This paper presents basic chemical composition and mineral contents of fresh meat, as compared to meat osmotically treated in sugar beet molasses. It was detected that dehydrated product shows enhanced chemical composition and considerable increased mineral content, thus confirming the usefulness of molasses from a nutritive point of view. The enrichment of the meat in protein, fat, sucrose, sodium chloride and analyzed minerals (K, Na, Mg, Fe and Ca) proves their diffusion from molasses into the raw material during process.

1. INTRODUCTION

Meat is a very important foodstuff in human nutrition because it is a rich source of biologically and nutritionally valuable ingredients, protein and essential amino acids, fat, minerals and vitamins (1).

Fresh pork meat has the highest percentage of water which has the significant impact on the physico-chemical, sensory and technological properties of meat (2). In order to prevent spoilage of meat and with the aim to obtain better quality and sustainability of meat many techniques for reducing water content have developed. These traditional processes are salting, drying, cooking, smoking, marinating and their combinations and they are carried out by placing product (meat) in contact with a concentrated solution (salt, sugar, acid, seasonings, etc.) (2,3).

These preservation methods have been applied to prolong the shelf life of meat, but produce meat products that are low in quality compared to their original fresh state. During these processes care must be taken to protect the nutritional and organoleptic (taste, smell, texture and appearance) properties of meat (4). Osmotic dehydration (OD) is an effective way to reduce the water content in processed product before further drying, additionaly improving sensory, functional and even nutritional properties (5). Compared to the other preservation treatments OD shows significant advantages: environmentally acceptability, energy efficiency, providing stable and quality products (6).

OD is a process of the partial removal of water by direct contact of foods (fruit, vegetable, meat and fish) with a suitable hypertonic solution. Driving force for water removal is the concentration gradient between the surrounding solution and the intracellular fluid (7). During OD, water from the plant or animal tissue flows out into the osmotic solution while osmotic solutes diffuse from the solution to the tissue. Simultaneously, third transfer process takes place, leaching of tissue's own solutes into the osmotic solution, but it is quantitatively negligible compared to the first two transfers (8).

The choice of optimal hypertonic aqueous solution appears to be the key problem in OD, and aqueous solution containing sodium-chloride and saccharose has been proposed as the best

solution (9). High salt concentrations decrease the water holding capacity, which contributes to meat dehydration and shrinkage while there is no swelling of muscle fibers or myofibrils (2).

Sugar beet molasses emerges as an appropriate medium for OD primarily due to the high dry matter and specific nutrient content. The application of sugar beet molasses as osmotic agent has many advantages: it is nutritionally richer than sucrose and NaCl, sensory acceptable, always accessible and cheap raw material (10). Also, sugar beet molasses can be used in the osmotic dehydration process without previous preparation and therefore leads to saving of process time and energy. High content of solids (around 80%) provide high osmotic pressure in the solution and allows greater loss of water during osmotic dehydration and thus enhances the efficiency of this process. On the other hand, specific chemical composition of molasses (approximately 51% sucrose, 1% raffinose, 0,25% glucose and fructose, 5% proteins, 6% betaine, 1,5% nucleosides, purine and pyramidine bases, organic acids and bases) enriches nutritional composition of dehydrated products (11).

The objective of this work was to investigate the influence of sugar beet molasses, applied in the process as hypertonic solution, on the nutritional quality of pork meat.

2. MATERIALS AND METHODS

Pork meat (*M. triceps brachii*) for the experiment was purchased on the local butcher shop in Novi Sad, shortly before use. Initial moisture content of the fresh meat was 74.40%. Before the osmotic treatment, fresh meat was cut into cubes, dimension of approximately 1x1x1cm. Sugar beet molasses, used in the process, was obtained from the sugar factory Pećinci, Serbia. Inital dry matter content of sugar beet molasses was 79.45%. The material to solution ratio of 1:5 was used during experiment. The experiment was carried out under atmospheric pressure at the room temperature of 22°C. The process was performed in laboratory jars. Sample of meat was dipped into sugar beet molasses, and the immersion lasted for 5 hours. On every 15 minutes meat sample in osmotic solutions was manually agitated to provide better homogenization of the osmotic solution. After 5 hours meat sample was taken out from osmotic solution and then lightly washed with water and gently blotted with paper towels to remove excessive water from the surface.

The content of mineral matters was determined in accordance to SRPS ISO 6869/2004 (12). The content of dry matter was determined in accordance with the requirements of the Serbian National Regulation (13). Determination of the content of NaCl was done by the SRPS ISO 1841-1/1999 (14); determination of the ash content was done by the SRPS ISO 936/1999 (15); determination of the protein content was done in accordance to the AOAC 992.15 methods (16); determination of the fat content was done by the SRPS ISO 3496.2002 (17); determination of the total phosphorus content expressed as P_2O_5 was done by SRPS ISO 13730/1999 (18); determination of the sucrose content was done using Luff-Schoolr method. For each determination measurements were performed in triplicate.

3. RESULTS AND DISCUSSION

3.1 Chemical composition of meat before and after OD

Initial weight of meat sample before treatment was 100g, and after 5 hours of dehydration was measured weight of 75.10 g for dehydrated meat product. Chemical analysis was performed to achieve a better understanding of the mechanism involved in three simultaneous flows that take place in the process of dehydration. Based on mass balance of

the chemical composition of meat before and after OD it is possible to quantitatively and qualitatively define the mass transfer occurring during the dehydration process.

In table 1 chemical contents of fresh and osmotically dehydrated pork meat are shown to represent the changes of the quantity of chemical components: dry matter, protein, fat, ash, sodium-chloride, sucrose and phosphate in the meat after OD.

Table 1. Chemical composition of dehydrated meat sample compared to the initial meat sample

Chemical parameter (g)	Fresh pork meat (100g)	Meat dehydrated in molasses (75,10g)
Dry matter	**25.60**	**41.46**
Ash	**1.12**	**2.85**
Protein	**20.78**	**21.14**
Fat	**6.65**	**6.72**
NaCl	**0.00**	**0.18**
Sucrose	**0.00**	**8.79**
Phosphate	**4.97**	**3.84**

Dry matter content (DMC) of the unprocessed pork meat was 25.60g, and result for DMC in processed meat was 41.46g. These data point out on increase of solids for 15.86g, which represents the amount of dry matter that penetrated from molasses into the meat submerged in it. When added up and subtracted mass of examined chemical compounds that entered and left the meat sample during dehydration, it can be concluded that the DMC of dehydrated sample was increased for 10.04g. Remaining 5.82g of dry matter that penetrated into the treated meat are compounds that are not analyzed in this study. On the other hand, initial water content in meat was 74.4g, whereas after OD was 33.7g. This means that 40.7 g of water has leaked from meat into molasses. The main aim of the OD process is obtaining high water loss from the fresh sample, providing products extended sustainability (19), as was achieved in this case.

The analysis was revealed that there were differences in quantity of the components which constitutes dry matter before and after OD. Starting mass of protein was 20.78 g, but after OD it was 21.14g indicating slightly increase of 0.36g. The increased protein content in final meat product is the result of the use of molasses as osmotic solution. Sugar beet molasses contains about 5% proteins (20), and it is possible that some of them diffuse into the meat dipped in molasses. The increase of protein composition is desirable since proteins are an important source of essential amino acids necessary for human organism (1).

The ash content in meat before OD was 1.12g, whereas after this process was 3.8g. There was an increase of 1.73g because of diffusion of substances which make ash from molasses into the final product.

The change in fat content in dehydrated meat is negligible compared to the initial fat content. The process of OD with molasses as osmotic solution increase content of fat in meat on average about 0.1 g. The fat is an important source of energy, but in certain

circumstances and in inappropriate proportions has a negative effect on human health (21). Taking this fact into account a slightly increase is still acceptable.

Based on the results of chemical analysis it was observed that 0.18 g of sodium-chloride was entered from molasses into the meat product during dehydration. Reduced salt intake is important from the health point of view (21). Therefore, the low enrichment of final product with salt gives advantage to the molasses in relation to the conventional osmotic solutions that lead to penetration of greater amount of salt.

On the other hand, quantity of sucrose was noticeable increased after process of OD. Compared to the fresh state of meat that was not contain sucrose, in dehydrated product was measured 8.79g of sucrose which was diffused from molasses. Considering the high concentration of sucrose in molasses (approximately 50%) evident increase of sucrose content in dehydrated meat was expected (20).

Salt and sucrose can increase the water-binding and fat-emulsifying capacities of the myofibrillar proteins and improve the taste of the final products. Increasing water-binding, NaCl and sugar, favorably affect on the texture of meat. Although, higher amounts of salt are undesirable because lead to protein denaturation and decrease water-binding (24,25). Due to the high sucrose concentration in molasses, by the presence of sugar, salt impregnation is hindered (24). For this reason, molasses is a suitable medium for dehydration causing increase of salt and sucrose in desired quantities for product quality.

In the case of phosphate an opposite mass transfer was occurred. From meat sample was flow out 1.12 g of phosphates into the molasses underway the process. From the health aspect, reduction of phosphate content is reasonable because large amounts of phosphorus in the human organism can cause certain health problems such as damage and degeneration of cells kidney, mainly as a result of precipitation of calcium phosphate. Also, excess phosphorous disrupts the absorption of calcium in the intestine, which has a result in the release of calcium from the bones (23).

3.2 Mineral composition of meat before and after OD

It is well known that the minerals have irreplaceable significance for normal functioning and revitalization of every organism, they are necessary for specific metabolic functions and their role in maintaining health is very important (9). In this study mineral composition of meat before and after OD was determined.

Table 2 is shown the changes of the contents of the analyzed mineral components (K, Na, Mg, Fe and Ca) in the pork meat dehydrated in sugar beet molasses.

Table 2. Mineral composition of dehydrated meat sample compared to the initial meat sample

Mineral substances (g)	Fresh pork meat (100g)	Meat dehydrated in s molasses (75.10g)
K	0.471	1.164
Na	0.089	0.259
Mg	0.032	0.042
Fe	0.002	0.003
Ca	0.014	0.072

Sugar beet molasses is rich in minerals and other biogenic substances, and contains about 4g/100g K (20). Diffusion of this mineral was occurred from the molasses into the meat sample, so an increase in the content of K took place in the treated meat. From this result it is possible to conclude that the content of K was about 2.5 times higher in comparison to the amount of K in the starting, non-dehydrated meat.

The content of Na was slightly increased in treated meat product, for 0.17g. Final Na content of meat was 0.259g. From the health point, this amount of Na in meat is in the acceptable range considering that the value of recommended daily sodium intake amount is 2.4g. Recently, emphasis has been placed on reducing level of salt in meat products in view of its relationship to hypertension, since the sodium is the component of salt that causes increase in blood pressure (21,22). Sugar beet molasses contains small amount of salt, less than 1g (20), and for this reason, application of molasses as osmotic agent is preferred.

Based on the analysis it was found that the content of Mg, Fe and Ca was increased in dehydrated sample of meat that enhanced its nutritive value. The increase of Mg and Fe was expressed in a slightly extent, but increase of Ca was more expressed. About 0.06g Ca was penetrated from molasses into the meat during dehydration. The increase of Ca content is considerable, highlighting the fact that the Ca is important element useful for bone development and growth (22).

4. CONCLUSIONS

On the basis of presented results, a general conclusion is that the use of sugar beet molasses during OD improves the nutritional profile of meat.

After osmotic OD was obtained meat product with increased content of protein, fat, salt and sucrose in appropriate extent, except of phosphates, which content was reduced. The chemical components in the obtained meat product are in optimal quantities for human health. It can be considered that the dehydrated meat product has the characteristic of functional food.

By analyzing the content of mineral components (K, Na, Mg, Fe and Ca) in the sample osmotically dehydrated in sugar beet molasses increase the amount of mineral substances, particularly K, was observed. Therefore, dehydrated meat has enhanced nutritional properties.

The presence of complex solute compositions in molasses maintains a high transfer potential favorable to water loss, and at the same time to impregnation of desirable nutritional compounds and minerals in meat product. Sugar beet molasses is suitable osmotic agent for OD process, and this study confirms usefulness of its applying.

ACKNOWLEDGEMENT

These results are part of project supported by the Ministry of Education and Science of the Republic of Serbia, TR-31055, 2011-2014.

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ETHANOL PRODUCTION FROM SUGAR BEET THIN JUICE BY IMMOBILIZED *SACCHAROMYCES CEREVISIAE*: CHARACTERIZATION OF VOLATILE COMPOUNDS

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ABSTRACT

The potential of by-products and intermediate products of sugar beet processing as raw materials for bioethanol production in Serbia has a big scope in view of the demand of ethanol as an alternative for fossil fuels. The production of bioethanol from sugar beet thin juice by *Saccharomyces cerevisiae* immobilized on sugar beet pulp (SBP) enables one more opportunity for achieving the zero-waste goal, through a rational use of intermediate and by-products of sugar beet processing. The effect of inoculum concentration on volatile compounds content of distillate was examined. The increase of inoculum concentration from 2.0 g/l to 2.6 g/l (dry mass basis) increased ethanol and aldehyde content of the distillate from 9.34 % v/v to 9.60 % v/v and from 238.6 mg/l a.a. to 301.5 mg/l a.a., but decreased methanol, acetic acid and ester content from 650.0 mg/l a.a. to 232.3 mg/l a.a., from 73.4 to 51.3 mg/l a.a., and from 272.0 mg/l a.a. to 220.8 mg/l a.a., respectively. The increase in inoculum concentration of SBP-immobilized yeast indicated improvement of distillate quality.

1. INTRODUCTION

Bio-fuels are attracting growing interest around the world, with some governments announcing commitments to bio-fuel programs as a way to both reduce greenhouse gas emissions and dependence on petroleum-based fuels. Bioethanol is by far the most widely used bio-fuel for transportation worldwide, because it is a renewable, nontoxic, biodegradable resource and it is oxygenated, thereby provides the potential to reduce particulate emissions in compression–ignition engines (Balat et al., 2009). Molasses and other intermediates from sugar beet processing are very good raw materials for ethanol production due to their high content of fermentable sugars, which can be directly used for fermentation without any modification (Rodríguez et al., 2010). In the sugar industry process, sugar beet (*Beta vulgaris*) is processed by extracting sliced beet cossettes with hot water (70°C) to produce the raw sugar juice. The raw juice is purified to get the thin juice with an average sugar content of 16%. The thin juice will be then concentrated in multiple steps resulting in a thick juice with an average sugar content of 67% (Krajnc and Glavić, 2009). Using immobilized cells in ethanol production is advantageous over free cells due to enhanced yield, ease to separate cell mass from the bulk liquid, reduced risk of contamination, better operational stability and cell viability for several cycles of operations (Chandel et al., 2007). As is well known, it is very important for the quality control of final fuel ethanol product, to ensure the absence of volatile compounds. In the present work the effect of inoculum concentration on volatile compounds content of distillate was examined in the case of sugar beet thin juice fermentation by *S. cerevisiae* immobilized onto SBP.

2. MATERIAL AND METHODS

Dried sugar beet pulp (SBP) from a sugar factory near the city of Senta in the Vojvodina province, Serbia was kindly provided and used as support for yeast cells. The SBP hydration was carried out by placing 25 g of DSBP on dry basis into 1 l Erlenmeyer flasks containing 500 ml of synthetic culture medium consisted of glucose (120 g/l), $(NH_4)_2SO_4$ (1 g/l), KH_2PO_4 (1 g/l), $MgSO_4$ (5 g/l) and yeast extract (4 g/l) at pH of 5.5, and was sterilized by autoclaving at 121°C for 30 min. After the sterilization, flasks were kept at room temperature for 24 h. Working microorganism was a commercial *S. cerevisiae* strain (Alltech-Fermin, Senta, Serbia), commonly used in Serbian baking industry, in form of pressed blocks (70 % w/w moisture). To immobilize cells on hydrated DSBP, the flasks were inoculated with 5 g/l of yeast on dry basis, and placed on a rotary shaker (120 rpm) in termostate at 30 °C for 24 h. After the immobilization of the yeast, the medium was decanted using sterilized gauze. Different amount of immobilized biocatalyst (2.0 g/l, 2.3 g/l and 2.6 g/l on yeast dry bases) was used for the batch fermentation of 500 ml of thin juice. Thin juice was obtained from the mentioned sugar factory. The total sugar content of thin juice was 155,53 g/l, pH was adjusted to 5.5 pH by addition of 10% (v/v) H_2SO_4 and it was sterilized by autoclaving at 121 °C for 30 min. The ethanol concentration of distillate was determined based on the density of the alcohol distillate at 20 °C, by pycnometer method (AOAC method 942.06, 2000). The content of volatile by-products (acetaldehyde, ethylacetate, acetic acid, methanol and furfural) of the distillate was determined by standard AOAC methods 972.08, 950.05, 962.12, 958.04, 960.16, respectively. Volatile by-products concentration were expressed as mg per liter of absolute alcohol (a.a.) in distillate.

3. RESULTS AND DISCUSSION

The ethanol content of distillate is presented in Fig. 1. On the basis of presented results it can be concluded that the ethanol content was increased along with increase of inoculum concentration.

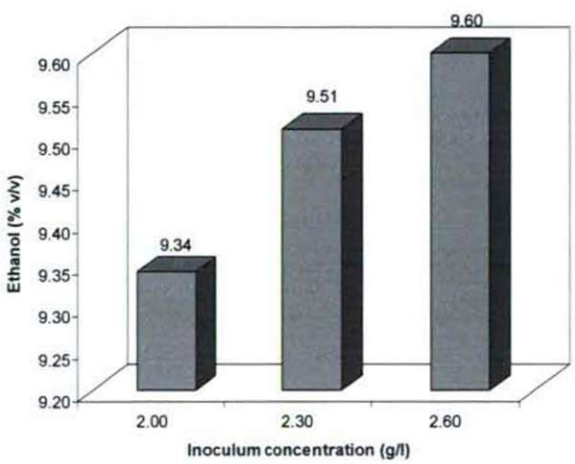

Figure 1. Ethanol content of distillate

The volatile by-products content of ethanol distillate after the fermentation using *S. cerevisae* immobilized onto SBP is shown in Fig. 2-5.

Methanol, which is derived from methylated pectic substances (pectin) by the action of pectic esterases (Reddy at al., 2008), showed a lower concentration in ethanol distillate obtained after fermentation with increased inoculum concentration.

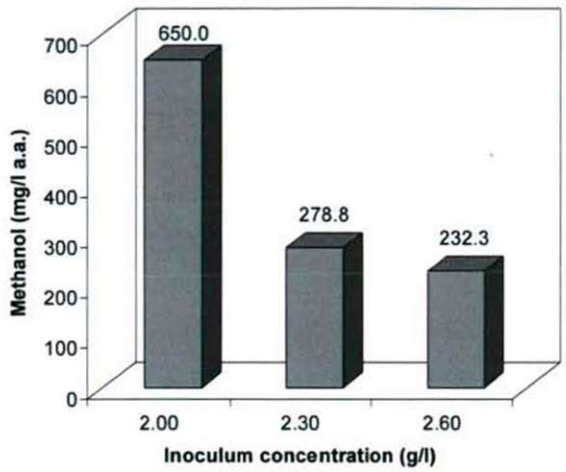

Figure 2. Methanol content of distillate

The levels of volatile acidity (expressed as acetic acid concentration) presented in Fig. 3. were significantly higher for lower inoculum concentration. This reduction of volatile acid content more pronounced in immobilized cells system with higher inoculum concentration, may be due to the very specific immobilization onto SBP as new biocatalyst. Besides, low volatile acidity was recorded indicating a high quality product.

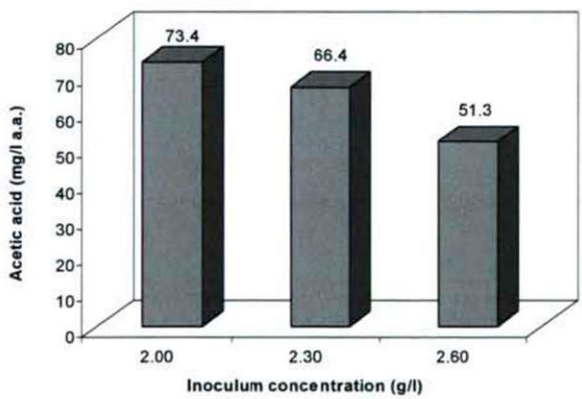

Figure 3. Acetic acid content of distillate

Esters (expressed as ethyl acetate), formed from the organic acids and alcohols during fermentation and secondary fermentation, play an important role in the formation of the sensory features. Their formation is catalyzed mostly by the yeast enzymes belonging to the group of esterases (Klosowski and Czupryński, 2006). The ester content of the distillate (Fig. 4) decreased along with increase of inoculum concentration.

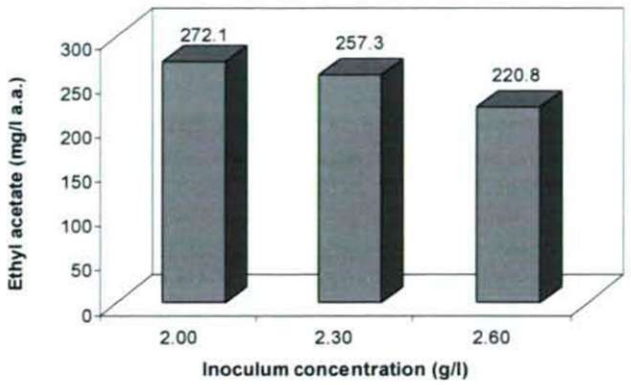

Figure 4. Ethylacetate content of distillate

Acetaldehyde, precursor of the acetates and ethanol, is formed from pyruvate by the glycolytic pathway enzyme pyruvate decarboxylase (Regodón et al., 2006). In contrast to other volatile compounds, the increase of acetaldehyde content (Fig. 5) was obtained along with increase of inoculum concentration. In this study the amount of aldehydes was significantly higher when inoculum was increased. Furfural content has not been determined in any sample of distillate.

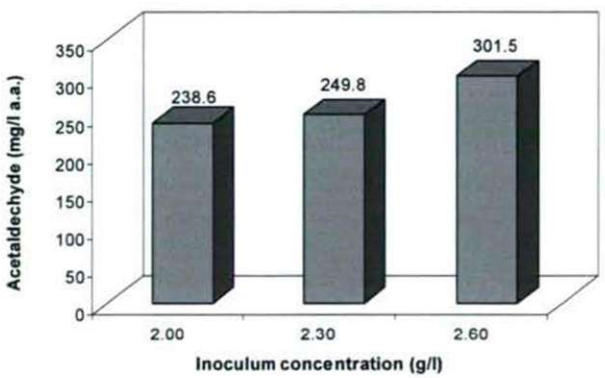

Figure 5. Acetaldehyde content of distillate

4. CONCLUSION

The increase of inoculum concentration from 2.0 g/l to 2.6 g/l (dry mass basis) increased ethanol and aldechyde content of the distillate from 9.34 % v/v to 9.60 % v/v and from 238.6 mg/l a.a. to 301.5 mg/l a.a., but decreased methanol, acetic acid and ester content from 650.0 mg/l a.a. to 232.3 mg/l a.a., from 73.4 to 51.3 mg/l a.a., and from 272.0 mg/l a.a. to 220.8 mg/l a.a., respectively. The increase in inoculum concentration of SBP-immobilized yeast indicated improvement of distillate quality due to the increase of ethanol content and descrease of methanol, acetic acid and ethylacetate content.

AKNOWLEDGMENTS

Financial support of the Project TR-31002 from the Ministry of Science and Technological Development of the Republic of Serbia is highly acknowledged.

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FINANCIAL INSTRUMENTS EU/RO ON SUSTAINABLE DEVELOPMENT OF RURAL AREA FROM ROMANIA. CASE STUDY: PERIAM LOCALITY, TIMIS COUNTY

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ABSTRACT

This paper presents sustainable rural development and its limiting factors, together with EU/RO financial instruments used in Romania, in financing programs available at present: ERDF, ESF, CF, EAFRD, and special funds wich include SCF and EUSF. Currently in Romania are available for application of the following financial instruments of the EAFRD, structured in 4 priority axes with 8 important measures. Rural development, regardless of geographic area, of ways of developing and the needs of local people must be made according to certain rules and take into consideration the limiting factors and only then can we talk about sustainable rural development.

As a case study, Periam locality, Timis County, was chosen, due to its geographical position, with great development potential and in order to attract European funds. A part of the locality is also located inside a natural park (The Natural Park Lunca Muresului). Given this they have a great responsibility regarding environmental protection not only in the park but also in the area around it.

In order to achieve a viable sustainable development of the human society, all these measures have a certain purpose, namely the maintenance of ecological balance to ensure conditions of living and working even better for future generations.

1. SUSTAINABLE RURAL DEVELOPMENT

The concept of sustainable development was crystallized over time, over several decades, in some depth scientific debate internationally and has gained political valences precise in the context of globalization. This concept requires drastic changes in almost all areas of life. (S.N.D.D.R., 2008)

One of the most commonly cited definitions stresses the economic aspects by defining sustainable development as "economic development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." (on the Brundtland report - 1986). (Man & Otiman, 2004)

Rural development includes all actions aimed at improving quality of life of populations living in rural areas, towards preserve natural and cultural landscape and to ensure sustainable development of rural areas according to specific conditions and those areas.

The concept of sustainable rural development began to take shape after the UNO Conference on Environment (Stockholm - 1972) and creating the World Commission on Environment and Development (1983).

People who can influence the course of rural economy life and that can participate in sustainable development of rural area are found in all structures:

* Each member of the community;
* chosen of local community (the mayor);
* government;
* parliament;
* civil society.

All have an essential role in creating and implementing a sustainable development mechanism, of any community. Rural development policies are needed, establish some strategies that take into account local diagnosis, the real evaluation of socio- economic life of

the individual and the community, of government programs and political orientations. (Man & Mateoc-Sirb, 2008)

Rural development policy focuses on three major aspects of society: agrifood economy, the environment and existing rural economy and population. The new generation of rural development strategies and programs will be built around a competitiveness axis for agriculture, food and forestry, an axis for land management and environment, and an axis for quality of life and diversification in rural areas.(www.madr.ro)

There are numerous constraints that restrict societal development. A few can be negotiated to some degree; most are unchangeable. The total range of theoretical future possibilities is reduced by these constraints, leaving only a limited, potentially accessible set of options, the accessibility space (Fig. 1). Societal development—whatever its form—will be restricted to the remaining accessibility space. (Bossel, 1999)

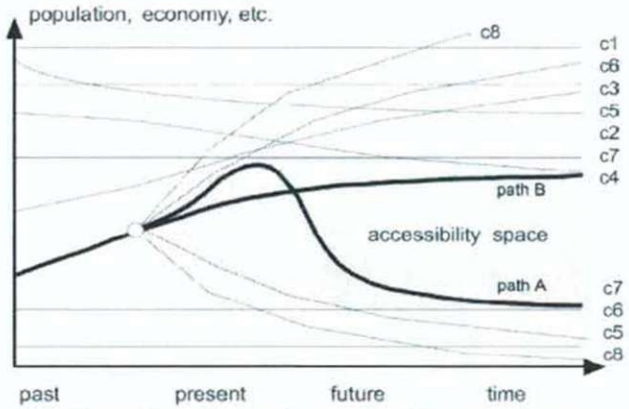

Figure 1. Development is constrained by various factors. These constraints leave only a limited accessibility space (after Bossel, 1999)

Following this chart we can see that sustainable development is possible, but the influence of several limiting factors such as:

Laws of nature, rules of logic: The laws of nature and the rules of logic cannot be broken. This implies restrictions that cannot be circumvented. Examples of such restrictions are the minimum nutrient requirements for plant growth, or the maximum energy efficiencies of thermal processes. Laws of nature, logic and permissible physical processes provide a first constraint, c1, on accessibility space.

Physical environment and its constraints: Human society evolves within, is dependent on, and is part of the global environment. Its development is constrained by the conditions of the global environment: available space; waste absorption capacity of soils, rivers, oceans, atmosphere; availability of renewable and non-renewable resources; soil fertility and climate. Sustainable development paths must adhere to these constraints. This is a second restriction, c2, of accessibility space.

Solar energy flow, material resource stocks: There is only one permanent energy supply on earth: solar energy. In sustainable development, the energy limitation is the rate of solar energy flux that can be captured and used by plants and technology. All material resources are limited to the present global supplies. Recycling is, therefore, also an essential requirement of sustainability. These energy and material constraints are a third restriction, c3, of accessibility space.

Carrying capacity: The carrying capacity is the number of organisms of a given species that can be supported by the region, given its (biomass) productivity and the demands of its

organisms. The carrying capacity of a region for humans depends on their material consumption. It is not only determined by food demand, but also by the demand for other resources (water, energy, rare metals, waste absorption, and so on). Carrying capacity is a fourth restriction, c4, of accessibility space. Humans can partially, and only temporarily, overcome the carrying capacity of a region by bringing in critical resources from other regions.

Human factors: Humans are self-conscious, anticipatory, imaginative, creative beings. This means that they are not restricted to act in narrowly confined ways according to fixed rules of behavior. They can invent new solutions — or they may not even see the obvious ones. This introduces as a fifth set of constraints, c5, on accessibility space.

Human organizations, cultures, technology: For a given society, and for the world as a whole, existing human organizations, cultural and political systems, available and possible technology and its systems, with their implications for behavior and the acceptance of change, will further constrain the accessibility space. This provides a sixth set of constraints, c6.

Role of ethics and values: Not everything that remains accessible will be tolerated by the ethical standards, or other behavioral or cultural values and norms of a given society. This introduces a seventh set of constraints, c7.

Role of time: All dynamic processes take time. For example, building infrastructure, or introducing a new technology, or restoring soil fertility, or stopping population growth, all take time, posing severe restrictions on what can be done, and how quickly or slowly things can be changed. Of particular importance is the ratio of rates of threat to rates of response: if responses cannot keep up with threats, viability and sustainability are at risk. That introduces an eighth set of constraints, c8. (Bossel, 1999)

Sustainable development and interdependence between economy and environment are important topics for the agenda of politicians, of civil society and, last but not least, of the scientific community worldwide. The growing interest for this concept has increased due to the return in the current concerns for increased production and consumption in the long term, due to limited resources and environmental constraints. (Man & Mateoc-Sirb, 2008)

2. FINANCIAL INSTRUMENTS EU/RO USED IN SUSTAINABLE RURAL DEVELOPMENT PROGRAMS

The new financial perspective discussed and voted by the European Union in 2005 covering the period 2007-2013 and includes 27 countries (including Romania and Bulgaria).

Most of financial instruments for development of rural area are focused on investing in rural infrastructure.

National Program for Rural Development (N.P.R.D.) 2007-2013 – program that award grants from the European Union and the Romanian Government for socio- economic development of rural space in Romania. Investors have new financial opportunities for investment projects in agriculture.

National Programme of Rural Development (N.P.R.D.) is the key document, based on which can be accessed European funds for agriculture. Common Agricultural Policy (C.A.P.) is a set of rules and mechanisms that regulate the production, processing and marketing of agricultural products in the EU and paying attention to rural development. (www.pndr.ro)

These funds, at regional level are identify with the NUTS EU system and at national level to which policy of regional development is implemented are NUTS 2 level. Funding from structural funds is made based on structural programs, on areas and priority objectives of regional policy and special funds works based on the project.

Since 2008, in the Structural Funds category, the most important are:

1) European Regional Development Fund (E.R.D.F.);

2) European Social Fund (E.S.F.);
3) Cohesion Fund (C.F.);
4) European Agricultural Fund of Rural Development (E.A.F.R.D.);

Special funds include:
1) Social Cohesion Fund (S.C.F.);
2) EU Solidarity Fund (E.U.S.F.); (Man & Mateoc-Sirb, 2008)

1) European Regional Development Fund (E.R.D.F.) is used to finance infrastructure projects, productive investment to create jobs and local development projects and to support SMEs. It was founded in 1975 and has the largest share of the Structural Funds, with the following direction of action (according to regulations of the European Parliament and Council 1783/1999):

- productive investment to create and maintain sustainable jobs;
- investment in infrastructure;
- investment in local development activities and business of small and medium enterprises;
- investment in education and health;

2) European Social Fund (ESF), created in 1958 as the main instrument of social community policy wich focuses on improving the functioning of labor markets in different countries and by integrating the unemployed into the labor market by ensuring operation of the following actions:

- professional training;
- Retraining;
- Creation of new jobs. (www.madr.ro)

3) Cohesion Fund (C.F.), founded in 1993, aims to fund projects of environmental protection field and improvement of trans-European transport networks in the European Union Member States whose GDP is less than 90% of EU average.

Financial support granted is not structured on programs but on projects, each project receives EU grant at a proportion of 80-85% of total eligible costs. (Man & Mateoc-Sirb, 2008)

4) European Agricultural Fund for Rural Development (E.A.F.R.D.) – is a financing tool created by the European Union, to support member countries in implementation of the Common Agricultural Policy.

European Agricultural Fund for Rural Development (E.A.F.R.D.) is dedicated to rural development measures for rural development programs funding and it is an financing opportunity for Romanian rural space, which is based on the principle of co-financing private investment projects.

Currently there are 8 active financing measures that include hundreds of types of investment in agriculture and rural development: *Measure 112*– Installation of young farmers; *Measure 121* – Modernisation of agriculture holdings; *Measure 123* – Adding value to agricultural and forestry products; *Measure 125* – Improving and developing infrastructure related to development and adaptation of agriculture and forestry; *Measure 221* – First afforestation of agricultural land; *Measure 312* – Support for the creation and development of micro-enterprises; *Measure 313* - Encouragement of tourism activities; *Measure 322* – Village renewal and development;

In Romania there are four development directions, as follows:

1) Restructuring and development of agricultural and forestry production, related manufacturing industry, given the improving of professional components, of a sustainable mamagement and compliance of environmental exacting;

2) Biodiversity and nature conservation will materialize through support,conservation and development of the forest , ensuring of a balance land occupation and development of sustainable management practices of agricultural and forest land;
3) Investment in rural infrastructure and rural services, a greater emphasis given on multi-functionality of rural areas, including conservation and valuing of cultural and architectural heritage.
4) Implementing local development strategies for improving administrative governance at rural level . (www.apdrp.ro)

3. APPROVED AND COMPLETED PROJECTS IN RURAL AREAS, VILLAGE PERIAM, TIMIS COUNTY

With Romania's accession to the EU (2007) Romanian rural communities, at the beginning with some reluctance, tried with help from the European funds, support from the Romanian Government and from own funds, to develop locality , to invest in infrastructure, economy, agriculture, environment protection, etc..

In order to observe better the phenomenon of sustainable rural development in Romania, it was chosen Periam locality, Timis County. Periam locality is a commune with about 4500 inhabitants, located in the western part of Romania, Timis County, in the north - western Banat Plain, at about 20 km from the border with Hungary. (Man & Stana, 2010)

Figure 2. Location of Periam locality. Access routes.

Due to its advantageous geographic position, Periam locality has great development potential in all points of view. Below are presented the number of projects that Periam has made each year from Romania's accession to the European Union.

Table 1. The number of completed projects (2007-2011)

Year	2007	2008	2009	2010	2011
Completed projects in Periam	4	6	7	10	14

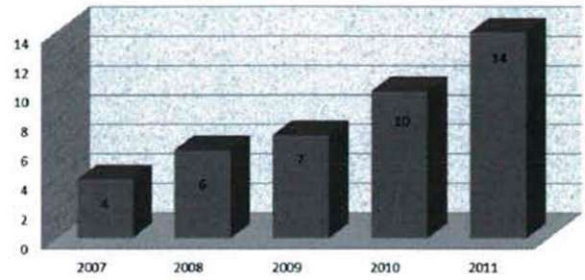

Figure 3. Number of projects completed in Periam locality, from 2007 until 2011

As shown, Periam locality began development of the locality since 2007 when they accomplished a total of 4 projects (street modernization in Periam, modernization of City Hall, rehabilitation of the kindergarten and the community center). Then every year, making a growing number of projects, reaching in 2011 a total of 14 completed projects (rehabilitation and commissioning the water tower, treatment plant, rehabilitation of pavements, modernization of the electricity network, etc.) plus 5 projects in progress.

1) Ecotur of the lower Mures between Periam Port and Mako

Financing: E.R.D.F. - The Program Cross-border Cooperation Hungary - Romania 2007 – 2013;

2) Ecological bridge over river Mures between Periam and Mako

Financing: E.R.D.F. - The Program Cross-border Cooperation Hungary - Romania 2007 – 2013;

3) Rehabilitation county road 682 (Periam- Periam Port)

Financing: Government of Romania;

4) Multifunctional sport base - Model type II

Financing: Government of Romania;

5) Kaula - Park. Project - Identity Landscape.

Financing: Government of Romania by the national program to improve environmental quality through the development of green spaces in localities

Approved for funding (HG 110/17.02.2011)

Because, in the locality are possibilities for development regarding to improve living standards, improve the environment quality, people want to change better image of the locality. Besides all these projects made so far, has a total of three approved projects that are expected funding for their start.

1) Modernization streets (7 km length) in Periam

Financing: Romanian Government through the National Infrastructure Development Programme "10000 km of county roads and local interest"

Approved for funding

2) Establishment of a home for the elderly, endowment the community center with national costumes and establishment of a marketplace.

Financing: E.A.F.R.D.

Eligible - on hold

3) Sewerage system from Periam

Financing: Government of Romania;

Approved by HG 1517, funding is not yet open

In conclusion we can say that Periam is one of the few localities in Romania who understood the expression of sustainable rural development. Sustainable rural development is

possible only when everyone is involved the mayor, local councilors, and town residents. Together, they can improve or even change the image of the locality.

Rural development, regardless of geographic area, ways of developing and needs of local people, must be made according to certain rules and considering of limiting factors, only then can we talk about sustainable development. (www.primatimperiam.ro)

4. ACKNOWLEDGMENT

"This work was partially supported by the strategic grant POSDRU 107/1.5/S/77265 (2010) of the Ministry of Labor, Family and Social Protection, Romania, co-financed by the European Social Fund – Investing in people."

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NATIONAL PRODUCTS IN TOURISM THE TOURISTIC ATTRACTIVE POTENTIAL OF LOCAL FOODS AND HUNGARICUMS

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ABSTRACT

My aim is to reveal the role of regional food products in terms of the local cunsumers' touristic motivation system. In order to do this, in the form of a quantitative survey I examine the respondents'consumption patterns, sources of information and knowledge and my purpose is to uncover some elements of the consumption motivation and system of attitudes.
In the planned research, I investigate mainly the local consumers' level of knowledge and attitudes with regional products and hungaricums. I choose the scope of components and touristic products from those which are under the origin protection of the European Union and from those which are products of the HÍR-collection or which are among the services of rural guest-table run by small-scale producers.

1. INTRODUCTION

Rural tourism has become a well-known phenomenon in our country since the 1990s. Every specialist agrees that the viability of family-sized agricultural enterprises are based on having multiple sources of income. Two of the important elements of this could be the provided bunk bed or rural guest-table service. In the last twenty years, however, several such enterprises have failed in which the investors have not measured the attractive potential of the given service correctly or they have not been able to provide efficient marketing back-up in order to create demand for the touristic product.This can be regarded as a serious disappointment because in several other European countries –involving the adjacent Austria- the family atmosphered accommodation is very much liked with home-made cooking and local products. Nevertheless, the ability to maintain the population in the Hungarian rural communities have radically deteriorated, the chances of employment are decreasing and there is a continuous immigration to cities by the young and the active age groups. This process, together with the problems of rural development contribute to the increase of social tension.

The food-hygienic regulation made by the European Union in 2004 made it possible for the member states the small-scale food-processing and the creation of the simplified hygienic regulation system in terms of locally sold foods. Technically, it results that if these do not reach the regulated amounts –the farmers are able to produce certain foods under less stringent conditions than large food companies. These are called products by small scale enterpreneurs by the Hungarian regulation. The local small scale regulation with the 2010 modification makes pig-killing, ox-roasting or making stewed mutton possible. The phenomenon of rural guest-table was also introduced in 2010 which, opposed to the former and similar regulation, makes it possible to offer more kinds of products and allows catering for bigger number of guests (the previous barriers did not allow catering for a busload of guests). The modification of the 2010 Excise Act, simultaneously, makes it possible the offering of the home-made spirit – which can be called 'pálinka' in the case agreement with the spirit law. The aim of these measures is definitely the boosting of rural tourism by improving the attraction of rural catering with gastronomic specialties.

There is also a program called Traditions- Tastes –Regions which aims the improvement of national dish and food culture. The central element of the program is a collection (HÍR-collection) which collects those traditional Hungarian products – with recipes

and photographs- which can be regarded as unique and typical only of Hungarians. According to information deriving from administration the HÍR-collection will make up the basics of the food parts of the national depository (hungaricum collection) which is still in the preparation phase. These products with their outstanding quality and specialty serve as a curiosity not only for local but for foreign guests and besides sufficient promotional activity they can have serious attractiveness in the stimulus of touristic services.

One part of our hungaricums are also appreciated by the European Union and are included in its own origin protection system. This system – which involves geographical indications and the collection of traditional special products – is managed by the Ministry of Rural Development in our country. The products under communal protection can be regarded such national food treasures which are internationally acknowledged. However, their awareness and attractiveness are below the expected level because of the insufficient marketing communication.

2. THE PRESENTATION OF THE TOURISTIC PRODUCT

The available free-time for the tourist and the disposable incomes play an important role in the determination of the touristic demand. At the same time, in the choice of destination the consumer's attitudes and motivation are crucial. Consequently, since the tourist's choice basically relies on his own inner values and feelings, motivation becomes a concrete travel decision through the attractions of the destination.

Certain elements of the touristic supply are interdependent. Due to the complexity of a touristic product the quality of a certain element influences the quality of the overall demand. The tourist does not only look for accommodation or food but such an experience which these are parts of- in some cases determining parts- nevertheless the combination of these factors gives the complex touristic product. It comes from the interdependece of the elements of supply that the bad quality of one or two components is able to spoil the whole product.

Small-scale products, hungaricums and foods which are origin protected can be regarded as such national food treasures which possess touristic potencial and are able to increase the value of the previously defined touristic products. They usually produce their effects as components of an outstanding touristic product however, in some caes they can become main components. Besides a nationally-awarded spirit, a type of wine, a mangalica domestic pig-killing or a special fisherman's soup in many cases the accommodation or the set play only a supporting role. In application of this study:

a) *branch depository:* the collection of the data of national values by competent national authorities
b) *Hungaricum:* such national value which is notable for differentiation and highlighting, which has been typical of the historic or today Hungary for many centuries or through generations or which has been produced recently with its uniqueness, specialty and has become a symbol of the Hungarians.
c) *National Collection of Hungaricums*: the collection of national values which have been declared as Hungaricums by the Committee of National Hungaricums
d) *Depository of cross-border communities:* the group of cross-border Hungarian minorities and the collection of recorded or national values under care
e) *Hungarian depository:* the collection of municipal, regional or branch depositories and the cross-border depositories of Hungarian communities
f) *Regional depository:* collection of national data under the area of the County Council
g) *National values:* such typically Hungarian products related to mental, generating activities, production culture, knowledge and traditions which are produced due to

mental, producing or artistic activities and are considered to be unique and special and which are regarded as significant from national point of view or at least one part of the country accepts as characteristic and well-known for the Hungarians and which can be characterised by Hungarian even abroad

h) *Municipal depository:* the collection of data of national values found in the area of the municipal depository

2.1. HUNGARICUMS

In recent years, due to the advantageous conditions, the care of Hungarian food culture has been appreciated. It was necessary, since after our accession to the European Union the possibility of direct supports which enable the Hungarian products to get to the market ceased. Partly due to this, the preparation of the law about the protection of hungaricums has been started.

Two parliamentary resolutions can be mentioned as the legal precedents of the hungaricum law. The first resolution – 77/2008. (VI.13) OGY resolution, about the protection of hungaricums – states that hungaricums represent unique national values and it calls on the government to work out the organisation of hungaricums together with science, government agencies, the regional and civil organisations, rural development intsitutions as well as develop the possibilities of their preservance and utilization.

One of the most important parts of the resolution that it classifies the collection of HÍR-program as a hungaricum.

The 77/2008.(VI.13) OGY resolution defines the definition of hungaricums: In the Hungarian-inhabited regions of the Carpathian basin a lot of values have been accumulated which as mental or food-industrial products- until this time- have survived the difficulties of the changing world. These values- which are uniquely and individually Hungarian specialties namely hungaricums – should be taken into account in our accelerated and globalized world. Hungaricums have geographical, historical, linguistic and ethnic images. Hungaricums are such special Hungarian products whose characteristic features are essentially and outstandingly Hungarian by character and which with their natural conditions, indigenous varieties and our growing and breeding traditions have a typical Hungarian criteria. The hungaricums with their characteristic of Hungarians, specialty and quality enhance our reputation and promote our appreciation in the European Union and all over the world.

The 122/2008. (XI.28) OGY resolution called on the government to hand in a law proposal with regards to the regulation of Hungaricums. The resolution indicates the aim of the regulation as follows: „After our accession to the European Union, in order to exploit market opportunities better it has become indispensable to differentiate the excellent quality, traditional and regional foods from from mass products"or „after our accession to the European Union the system of direct support opportunities have ceased in order to promote Hungarian products to get to the market. The common competition regulation lets only the traditional and special quality products to spend sources on in the power of member states. That is why the collection and care of national values have been highly appreciated.

Besides, there is an important aspect to the EU legislation: „The marking of geographical location and origin in the case of agricultural products and foods in the 510/2006/EK regulation makes it possible to appreciate such products whose special characteristic feature can be related to the geographical location, namely these products can be produced only within that geographical location which has become determined in the accepted product description."

2.2. Research ambitions

My aim is to reveal the role of regional food products in terms of the local cunsumers' touristic motivation system. In order to do this, in the form of a quantitative survey I examine the respondents'consumption patterns, sources of information and knowledge and my purpose is to uncover some elements of the consumption motivation and system of attitudes.

In the planned research, I investigate mainly the local consumers' level of knowledge and attitudes with regional products and hungaricums. I choose the scope of components and touristic products from those which are under the origin protection of the European Union and from those which are products of the HÍR-collection or which are among the services of rural guest-table run by small-scale producers. During the research I apply the following issues:

- The level of knowledge of the chosen product
- Attitude in connection with rural tourism
- The attractiveness of the chosen products
- The attractiveness of other products and services
- General touristic consumer characteristics in case of the respondent
- Demographical factors

From the received results I expect that it will be possible to determine the touristic potential of regional products and hungaricums compared with other products.

2.3.Research results

The number of items in the recorded sample is 1282. 42,60% of the respondents of the questionnaire was man, 44,70% was woman. Unfortunately 12,80% did not give information regarding their sex.

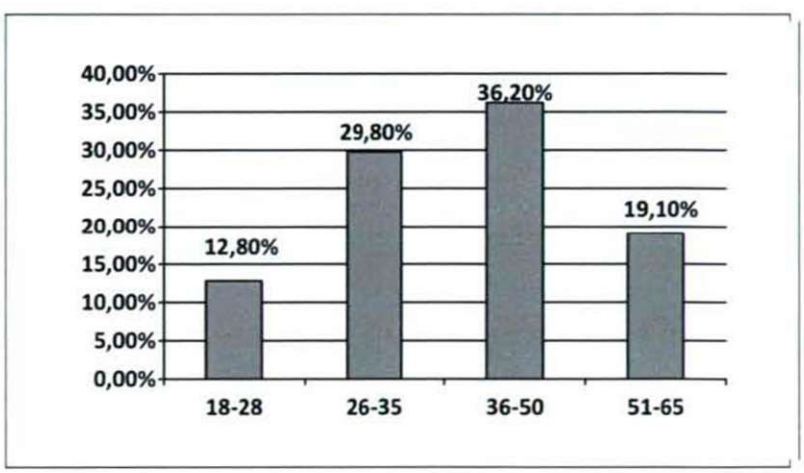

Figure 1. The distribution of respondents according to age

The age of the respondents was the following. 12,80% was those rate who were between the age of 18 and 25, 29,80% was between the age of 26-35, 36,20% was between 36 and 50 years old, 19,10% was 51-65 years old. There was no respondent over the age of 65. 2,10% was those rate who did not want to tell their age. The majority of the respondents

(44,70%) live in smaller towns, 29,80% live in county towns, 14,90% live in Budapest while 4,30% live in villages.

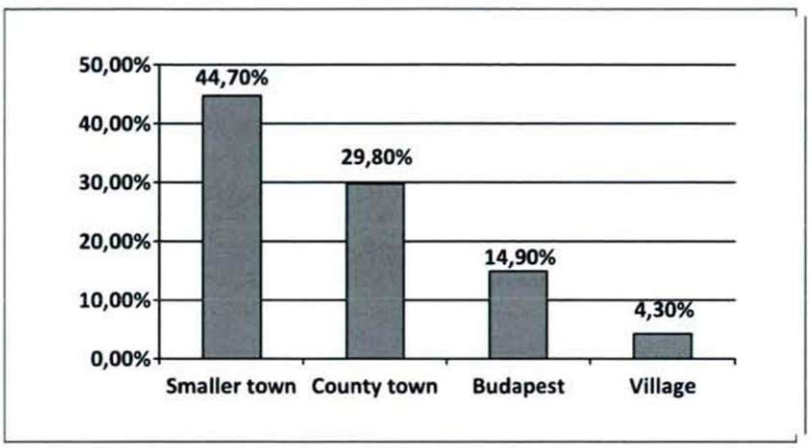

Figure 2. The distribution of respondents according to their place of residence

I also asked the respondents about the number of their children: The majority of the respondents do not have a child yet (52,20%), 13% of them have one, 28,30% have two, 4,30% have three, 2,20% have four children.

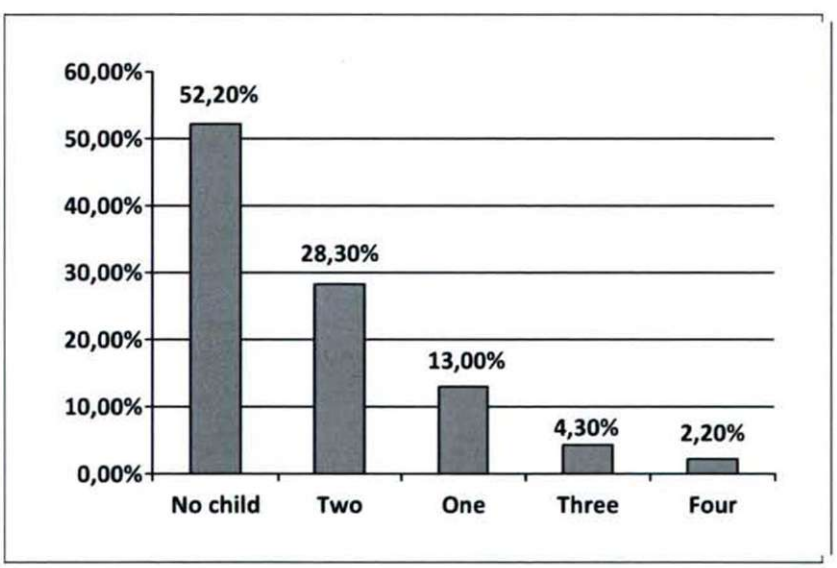

Figure 3. The respondents' number of children

Considering the highest school of the surveyed people, 4,30%have completed primary school, 25,50% of them have completed secondary school, 66,0% have completed college or university. 4,30% did not answer. 40,40% of the respondents have completed studies in connection with food industry or agriculture, 53,20% are not connected to them. 6,40% did not answer the question.

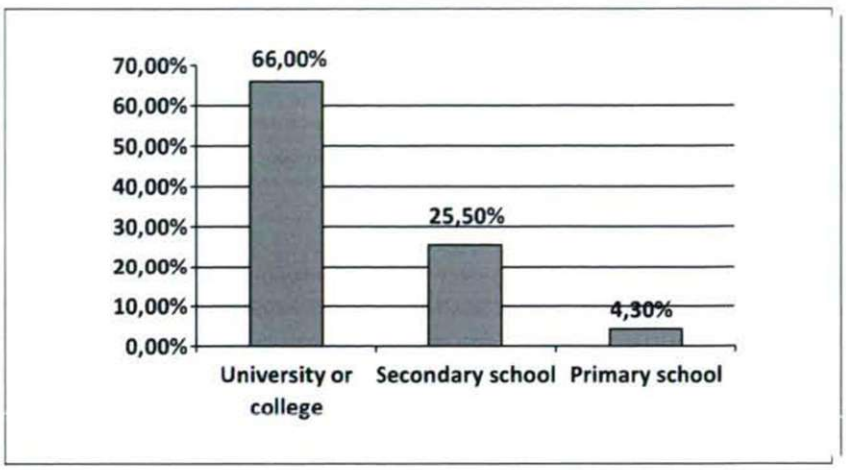

Figure 4. The respondents' highest completed school

The first part of the questionnaire dealt with travel habits. The majority of the respondents (36,20%) have the chance to travel somewhere with the purpose of relaxation where they stay for at least one night, the least number was of those (2,10%) for whom it is possible almost every wekend. 12,80% go on holiday about once a month, 17,00% go once in three months, 21,30% go once in a half year while 10,60% do not even remember when they went on holiday.

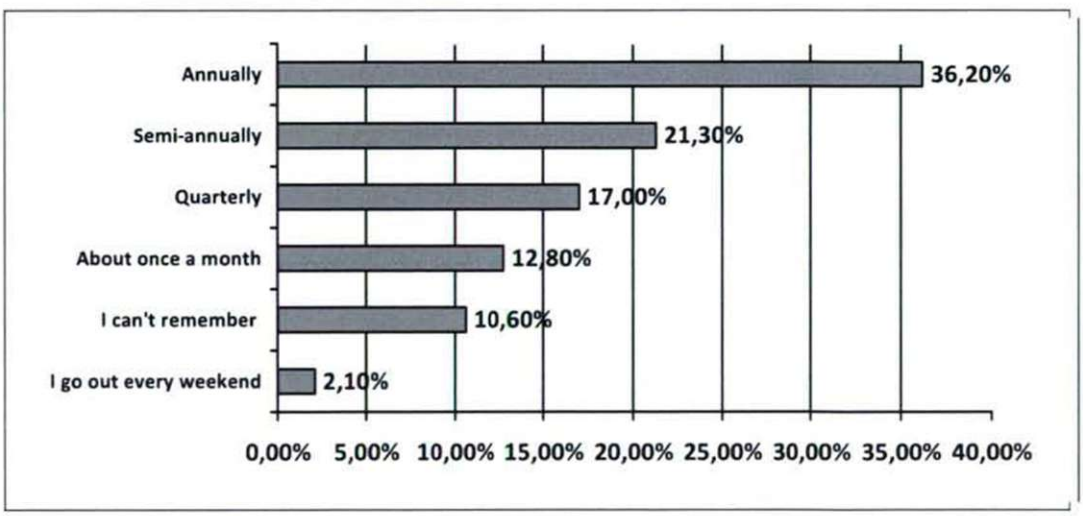

Figure 5. The frequency of travellings with **the purpose of relaxation**

In order to survey what distance a respondent travels in a case of travelling, I listed statements which had to be assessed from 1 to 5 by the respondent. They had to write 1 next to the statement which was practised the rarest and they had to write 5 next to the sentence which was the most frequent. According to the statistics it can be claimed that the respondents stay in Hungary the most frequently when they relax: the average is 3,68 through which the

biggest part of the respondents assessed 5. The average is almost the same (3,61) in the case of destinations within Europe: at this statement 48% of the respodents marked 5. In the rarest case a destination outside Europe was chosen since in this case the average was 1,63 and 68,3% marked 1. In the case of a regional destination the average was 2,57%.

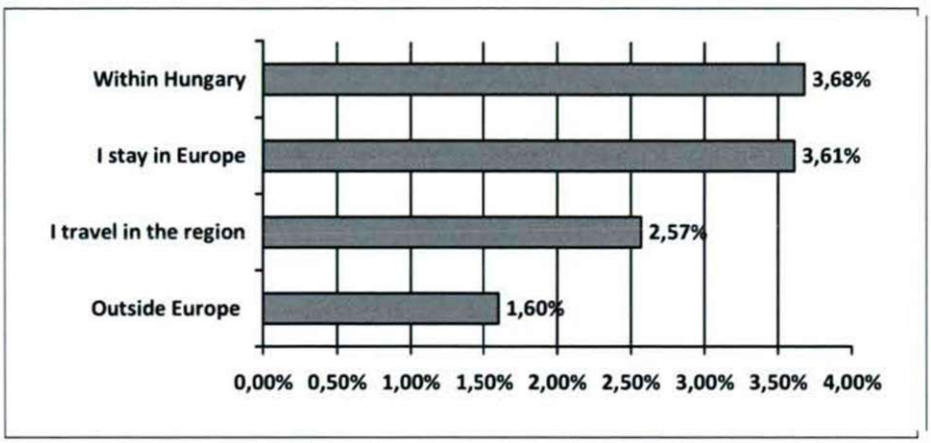

Figure 6. The distance of travel in a case of an outing

In determining the target of the travel the respondents were influenced by many factors. In the present case, respondents had to assess certain factors on the basis of a method seen above. Mark 1 means that the factor does not play a role at all, while mark 5 shows which plays the biggest role. For the respondents, the proximity of the resort is not particularly important since the average was 2,33. 42,2% gave mark 1 while visisting friends, relatives, festivals or village days received an average under 3. In the case of the former factor the average was 2,39 while in the latter the average was 2,57. The particularly cultural experiences factor received an average of 3. During the assessement of the survey it seems that the search of silence and peace and active relaxation received an avergae above 3, so it can be said that these influence the determination of the travel the most. The average of the previous factor was 3,26 in a way that 28,3% of the respondents gave mark 5, while the average of the latter was 3,53 in a way that 35,6% of the respondents gave mark 5.

The questionnaire also answers that question how much gastronomical values play a role in the choice of a destination. Overall, it can be stated that the respondents did not decide on their travel according to gastronomical values since while the average was 3,24 the factor in terms of which the respondent tends to discover the special food of a certain area, the average was under 3. The foods which can be related to national holidays (such as the Márton-day goose) mainly do not motivate people for travelling (43,5% gave mark 1, the avergae was 2,15). People go to a gastronomicl festival because of its topic the rarest (40,9% gave mark 1, the avergae was 2,2). The respondents do not even go to wine tours either, since the achieved average was 1,73% (71,1% gave mark 1).

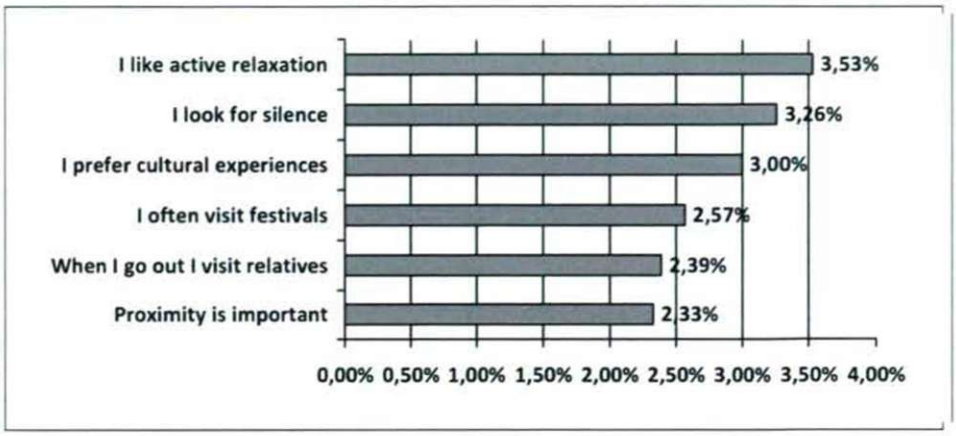

Figure 7. The role of certain factors in the choice of a destination

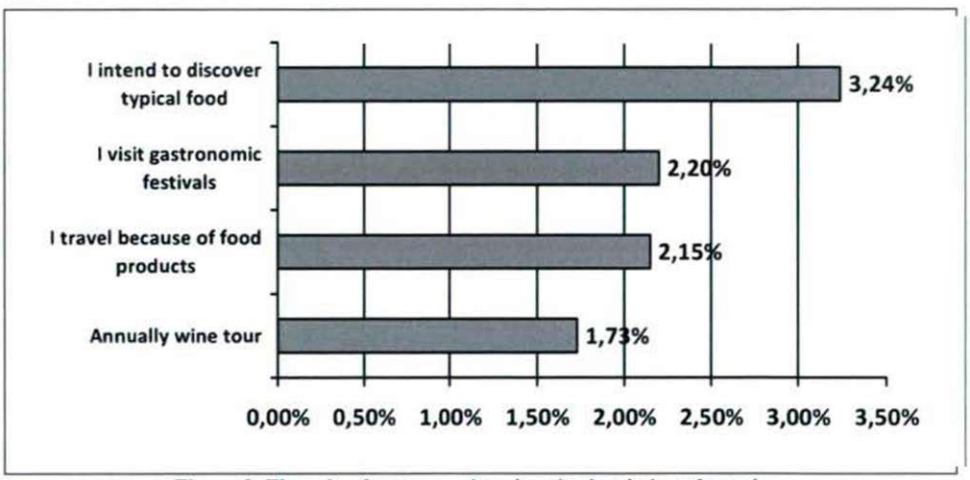

Figure 8. The role of gastronomic values in the choice of travel

I have also surveyed in the questionnaire how much respondents knew the meaning of the acronym: HÍR. From the four listed possibilities, the most people (80,90%) could choose the correct one. (Traditions-Tastes-Regions)

In the case of a product the trade mark on it meant something extra for most of the respondents, since 40,40% thougt that it helped in the orientation among products which have similar features. 17,00% do not really know what kind of trade marks exist. For 12,80% thye do not mean additional value, since they do not believe in the reality behing the trade marks. 25,50% intentionally looks for those trade marks in which they trust.

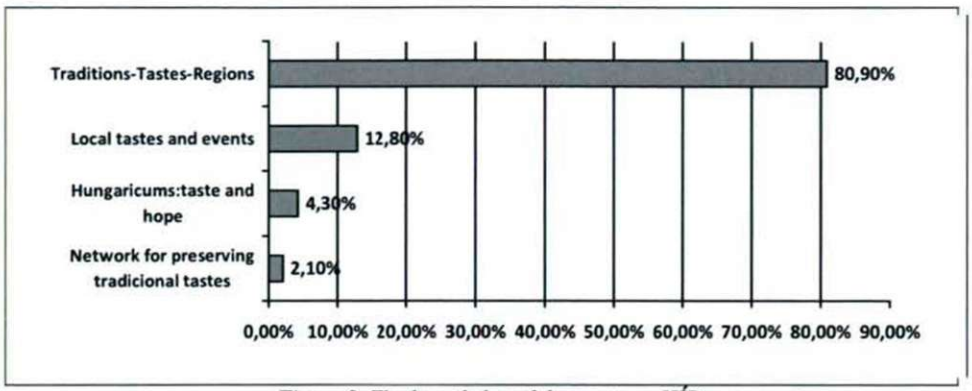

Figure 9. The knowledge of the acronym HÍR

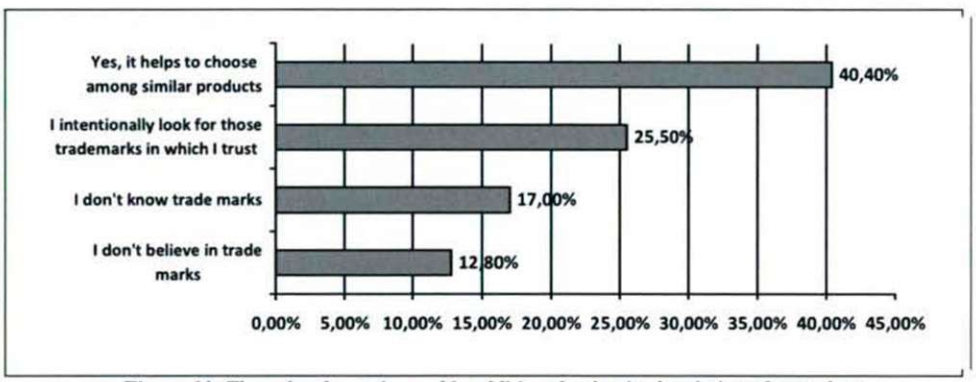

Figure 10. The role of a trade mark's additional value in the choice of a product

The respondents of the questionnaire obtain information to organise a certain trip from acquaintances (average 3,49%) or former personal experiences(average 3,78). The oter factors had results under the average of 3 but over 2: news on tourism (2,78%), blogs, socila networking websites (2,09%), the own marketing of the catering establishment (2,82%), by chance (2,22%).

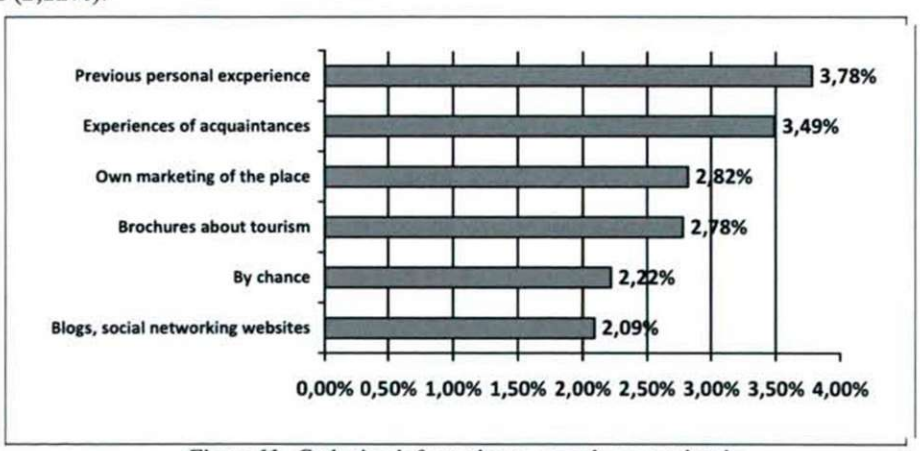

Figure 11. Gathering information to organise a certain trip

According to the majority it is very typical tat Hungarian food products have a positive influence on the Hungarian economy, 4,20% of the average, 56,8% of the respondents gave mark 5 which means "very typical" in this case. Proportionately there are only a few of those who believe that Hungarian food products are better flavoured than import food products (the average is 3,67%) which means they are traditional (3,57%), reliable and safe (3,61%). The lowest averafe belongs to the innovative feature of Hungarian food products.

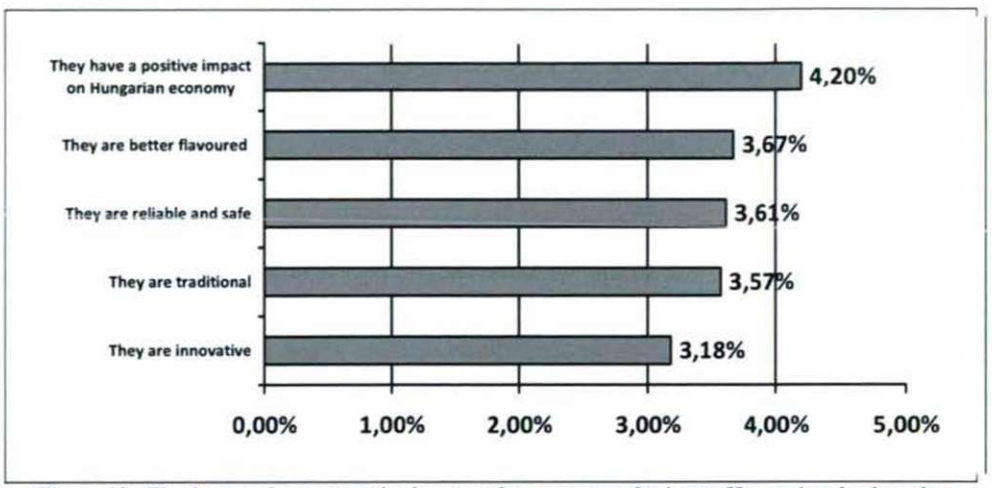

Figure 12. The degree of agreement in the case of statements referring to Hungarian food products

I interviewed the consumers how much certain features are typical of small-scale food products. The average of the marks was between 3,50 and 3,91 to features tat I listed. The following result has concluded: reliability 3,72, good quality 3,74, traditional taste 3,91, environmental sustainability 3,51, the development of rural life standards 3,91, direct link between the producer and the customer 3,91.

Figure 13. The degree of agreement in the case of statements referring to small-scale food products

The tenth question of the survey was rather though-provoking since the rspondents had to match the listed trade marks with their definitions. Only 14,90% of the surveyed thought correctly that Traditions-Tastes-Regions meant the collection of traditional and regional

agricultural food products in which the Hunagrian pastry could be also found. A product can receive the Excellent Hungarian Food trade mark which is high quality and reliable. Only 23,40% of the respondents could give the correct answer to this.

3. CONCLUSIONS

Although the concept of rural tourism has been known for almost 20 years in our country, one of its important components, the rural guest-table service could not become widespread yet. In spite of the several western examples, the Hungarian attempts could not confirmed, although rural tourism could become one of the important factors of rural development through which the rural living standard and population-maintaining reduction could contribute to the mitigation of social tensions.

The 2004 food-hygienic European Union regulation and its Hungarian counterpart made it possible that if the farmer cannot reach a certain amount of products he can produce food under less strict conditions. The additional values and cultural and social roles of small-scale food products are considered to be essential by a lot of authors in the field of rural development. Some modifications of national legislations in 2010 (the possibility of pig-killing, ox-roasting, the expansion of catering for a bigger number of people, local spirit producing) make an attempt to boost national rural tourism by promoting gastronomic attractions in order to improve catering. Some further parts of the efforts with regard to the boost of rural tourism is the Traditions-Tastes-Regions program, or placing some parts of the hungaricums under national protection, and the new draft law about Hungarian national values and hungaricums.

According to the draft law, based on municipal, sectoral and cross-border values a complex collection, the National Depository would be established and from that the hungaricums would be selected which would stand on the top of the Hungarian Depository.

In order to make a product a hungaricum, different ministries and civil organisations could make a suggestion. Afterwards, they will have a distinguishing value, they will get a trade mark, so their marketing value will be rather big. On the other hand, however, since Hungary is a European Union member state it cannot encourage customers to buy Hungarian products. The most important results of my survey with regard to the level of knowledge and attitudes of local consumers are shown below. The local consumers usually leave their homes with the purpose of relaxation annually, through which tey spend their free time in our country the most frequently or by leaving their region they spend it in Europe. In the choice of the place of relaxation the active leisure, tranquillity and silence play the most important roles. Moreover, from the given answers it seems that people obtain information in connection with the place from friends and acquaintances. In this way, the average consumer discovers the gastronomic values of the area but it is rare that gastronomy would attract the travel to a certain place (taking part in wine tours plays the least role). I consider to be a positive thing that several people are aware of the meaning of the HÍR acronym. The majority of consumers do not only know certain trade marks but those also possess extra values in the chioce of a certain product. In connection with Hungarian food products consumers mainly think that they have a positive effect on Hungarian economy, they are better flavoured than import goods and they also agree with that they are reliable, safe and traditional. In the case of small-scale food products most of the people agree with the listed features (direct relationship between the producer and customer, the improvement of rural living standards, traditional tastes, environmental sustainability, good quality). Nevertheless, it turned out from the survey, that the responsdents hardly feel the impact on environmental sustainability.

We can conclude from the given answers that the touristic attractive potential of local food products cannot be considered high. Gastronomic values do not play a crucial role in the choice of the destination of relaxation although it does not mean that this attitude remain the same in the future. It would be important to create that secondary attraction level which can mean regional products or local tastes, food specialties and their ethnic or historic values. The 2010 innovations in Hungarian legislation and the expectable further policies with the inclusion of gastronomic attractions they will hopefully promote the boosting of rural tourism which would have an important role in the development of the countryside and national economy.

The aim of the government and ministries is to harmonize, integrate and complete the existing systems of values (Hungarian product, excellent Hungarian food, wine competitions, the master of folklore, masterpiece of craft, attraction inventory, common treasure, valuemap, torque, folkdance classification) and the activisation of society on local, regional and national levels.

The purpose is the awareness of our facilities, possibilities and specificums and the better exploitation of these at home and beyond the borders as well as the creation and operation of a value-based complex system.

The effect of the Hungaricum law may be the better exploitation of our agro-potencial, the support of turism and rural tourism, the incentive of consuming and producing national food and by these creating new workplaces.

Researchers taking part in tourismresearch agree that our values on rural places – which can be connected to folk traditions or can be based on folk traditions or intangible heritage between the man and the nature which surrounds him- must be protected and maintained. The forms of productions at the productive places, the characteristic features of the given lands and the people's traditions with production carry priceless valuesthere the productive places of the area and the places which preserve traditions deserve more attention. The creation of respecting values based on real self-esteem would help in protecting these cultural places.

The government with the creation of the Hungaricum system, the involvement of local values and the stagnant parts of the country improves the economic, turistic, gastronomic, cultural and social efficiency of the country.

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EFFECTS OF TEMPERATURE AND IMMERSION TIME ON REHYDRATION OF OSMOTICALLY DEHYDRATED PORK MEAT

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ABSTRACT

The aim of this work was to study the changes in osmotically dehydrated (OD) pork meat during rehydration. Meat samples (1x1x1cm cubes) were osmotically treated in two solutions: (1) solution with 350g of NaCl and 1200g of sucrose diluted in 1 l of distilled water and (2) sugar beet molasses (80 ^{0}Brix) solution at 23±2°C for 1, 2, 3 and 4 hours. In both cases, the solution to sample mass ratio was 10:1 to avoid significant dilution of the medium by water removal. After being osmotically dehydrated, meat samples were rehydrated by immersing meat cubes in water bath at constant temperature (20, 40 and 60 ^{0}C). The samples were removed after different immersion periods (15, 30, 45 and 60 min) and examined for mass and volume gain and rehydration percentage was calculated. After relatively short time (15 min), significant weight and volume gains were observed for both treatments. Process temperature was the most significant variable affecting final dry matter content and rehydration kinetics. At the end of rehydration process, conducted at 20 ^{0}C and 40 ^{0}C, a significant recovery in mass was observed, although the values were lower than for fresh meat. Ruptured and shrunken meat tissue produced as the result of OD had reduced its ability to absorb water. Rehydration percentage at 20 ^{0}C for molasses solution was 24.11%, and for sucrose-salt solution was 26.19%. However, rehydration at 40^0 C brings higher mass gain in case of molasses as a solution (11.33%) compared with sucrose-salt solution (7.88%). Results obtained at 60 ^{0}C were negative which means that rehydration didn't take place. The best conditions for meat rehydration were obtained using a temperature of 20 ^{0}C and time of 60 min. Volume of samples increased almost linearly with weight increment.

1. INTRODUCTION

The technique of dehydration is probably the oldest method of food preservation practiced by mankind (*Afzal, Abe, & Hikida, 1999*). Osmotic dehydration (OD) is a non-thermal process that consists in the immersion of a food material in a hypertonic solution. The difference of the chemical potential between the material and the solution promotes two main fluxes: the outcome of water from the material to the osmotic solution, and the income of soluble solids from the osmotic solution to the material. As osmotic agents are often used sugars (sucrose or glucose) and salts (sodium chloride).

In dehydration processes, heat and mass transfer flows can modify physicochemical properties of the material such as chemical composition (*McLaughlin and Magee 1998*), mechanical properties (*Lewicki and Lukaszuk, 2000*), volume and porosity. The quality of the dehydrated product depends on the extension of these changes. Regarding to the changes in volume and porosity, high shrinkage and low porosity lead to products with poor rehydration capability (*McMinn and Magee, 1997*). Furthermore, the changes in volume and dimensions must be considered for mass transfer modelling during dehydration (*Khalloufi et al., 2009*).

Volume changes during OD are mainly due to compositional changes and mechanical stresses associated to mass fluxes. These changes have been analyzed as variations in the volumes of solid, liquid and gas phases of the food material during the process (*Barat et al., 2001*), and have been correlated with changes in moisture content and WR (*Moreira and Sereno, 2003*), or with WL (*Nieto et al., 2004*).

Structural parameters such as sample volume, specific dimensions and porosity are closely related not only to food behaviour in mass transfer processes but also to other aspects such as food sensory and physical properties.

Dehydrated products need to be rehydrated before consumption or further processing (*Oliveira and Ilincanu, 1999*). During rehydration, absorption of water into the tissue results in an increase in the mass. Simultaneously, leaching out of solute (sugars, acids, minerals, vitamins) also occurs and both phenomena are influenced by the nature of the product and conditions employed for rehydration (*Krokida and Marinos-Kouris, 2003*). A study of rehydration kinetics can be used to ascertain the net extent of injuries sustained by any material during rehydration and any other processing step prior to it (*Lewicki, 1998a*). Rehydration is influenced by several factors, grouped as intrinsic factors such as product chemical composition, predrying treatment, product formulation, drying techniques and conditions and post drying procedure and extrinsic factors such as composition of immersion media, temperature and hydrodynamic conditions (*Oliveira and Ilincanu, 1999*).

The literature is inconsistent on rehydration characteristics with regard to food-to-water ratio, temperature of rehydration, level of agitation and procedure for the determination of moisture content (*Lewicki, 1998a*).

Rehydration can be considered as a measure of the injury to the material caused by drying and treatment preceeding dehydration (*Okos, Narishman, Singh and Weitnauer, 1992*).

It has been shown (*Steffe and Singh, 1980*) that the volume changes (swelling) of biological materials are often proportional to the amount of absorbed water. It is generally accepted that the degree of rehydration is dependent on the degree of cellular and structural disruption.

In some studies which consider food structure in the process modelling, changes in sample volume have been explained in terms of water loss throughout the process (*Andreotti, Tomassicchio and Macchiavelli, 1983*).

The time needed to reach the minimum volume was determined with a proposed equation (*Barat et al., 2001*). The initial shrinkage period was observed to be followed by a swelling period.

Response surface methodology (RSM) is an effective tool for optimizing a variety of food processes including rehydration (*Azoubel and Murr, 2003*). The main advantage of RSM is reduced number of experimental runs that provide sufficient information for statistically valid results. The RSM equations describe effects of the test variables on the observed responses, determine test variables interrelationships and represent the combined effect of all test variables in the observed responses, enabling the experimenter to make efficient exploration of the process.

The objectives of here presented article were to investigate the effects of temperature and processing time on the mass transfer phenomena during rehydration of pork meat cubes, that were osmotically dehydrated in sugar beet molasses or sucrose solutions, to model rehydration percent (R) and volume changes (dV), as a function of the process variables.

2. MATERIALS AND METHODS

Sample preparation

Fresh pork (Musculus brachii) was bought in local butcher store and transported to the laboratory where it was held at about 4°C for 1–2 h. The muscles were trimmed of external fat and connective tissues and manually cut into approximately 1x1x1 cm ($1cm^3$) cubes with shark sterile knives.

Osmotic dehydration (OD)

Meat samples were osmotically treated in
solution of sugar beet molasses (soluble solid content = 80 ^{0}Brix);
sucrose-salt solution in distilled water (solution with 350g of NaCl and 1200g of sucrose diluted in 1 l of distilled water)
at 23±2°C for 5 hours.

The solution to sample mass ratio was 10:1 to avoid significant dilution of the medium by water removal, which would lead to local reduction of the osmotic driving force during process (*Medina-Vivanco et al., 2002; Antonio et al., 2008*). Meat cubes were fully immersed and held in the solutions using wire mesh. Experiment was carried out using laboratory glasses (V=500 ml each). On every 5 minutes meat samples in osmotic solutions were mixed with hand-held agitator in order to induce sample - solution contact and provide better homogenization of the osmotic solution. After being removed from the osmotic solution, samples were gently blotted with a tissue paper in order to remove excessive solution from the surface and then analyzed.

Rehydration (R)

OD treated meat samples were rehydrated by immersing meat cubes in water bath at constant temperature (20^{0}C, 40^{0}C and 60^{0}C). The samples were taken from the bath at different immersion periods (15, 30, 45 and 60 min) and were weighted after being blotted with tissue paper in order to remove the excess water. Finally, rehydration percentage was calculated.

Rehydration was calculated as:

$$R(\%) = \frac{100 \cdot (M_t - M_0)}{M_0} \qquad (1)$$

where M_t and M_o are the sample`s mass at time t (rehydrated samples) and zero (dried samples), respectively.
Dry matter content of the fresh and treated samples was determined by drying the material at 105 °C for 24h in a heat chamber (Instrumentaria Sutjeska, Serbia).

Volume changes (dV) were calculated as:

$$dV(\%) = \frac{100 \cdot (V_t - V_0)}{V_0} \qquad (2)$$

where V_t and V_o are the sample`s volume at time t (rehydrated samples) and zero (dried samples), respectively.
Sample dimensions of meat cubes were measured before and after rehydration using digital caliper.
Measured results are presented in Table 1.

Table 1. Experimental design and data for the response surface analysis

Run No	Temp. (X_1)	Time (X_2)	R of sugar beet molasses trated samples (Y_1)	R of NaCl+ Sucrose trated samples (Y_2)	dV of sugar beet molasses treated samples (Y_3)	dV of NaCl+ Sucrose terated samples (Y_4)
1	20	15	11.072	9.272	3.592	4.565
2	20	30	20.012	17.389	6.049	5.413
3	20	45	20.196	23.159	4.089	7.287
4	20	60	24.114	26.186	14.914	9.597
5	40	15	5.536	2.010	3.681	10.078
6	40	30	8.599	4.430	16.099	22.615
7	40	45	12.679	5.447	16.218	15.953
8	40	60	11.331	7.887	16.336	9.291
9	60	15	-7.416	-8.022	16.138	9.056
10	60	30	-7.901	-8.830	8.524	18.947
11	60	45	-9.442	-11.087	-0.719	5.774
12	60	60	-10.952	-11.998	-9.962	-7.399

Response surface methodology

The RSM method was selected to estimate the main effect of solution type (sugar beet molasses or NaCl+sucrose) on mass transfer variables during the rehydration of pork meat cubes. The accepted experimental design was taken from *Box et al. (1960).* The independent variables were rehydration time (X_1) of 1, 3 and 5h and temperature (X_2) of 40, 50 and 60°C, and the dependent variable observed were responces: rehydrations of sugar beet molasses solution treated samples (Y_1), rehydration of NaCl+sucrose solution treated samples (Y_2), samples volume changes of sugar beet molasses solution treated samples (Y_3), and samples volume changes of NaCl+sucrose solution treated samples (Y_4). The accepted experimental design included 12 experiments.

A model was fitted to the response surface generated by the experiment design. The model used was function of the variables:

$$Y_k = f_k(temp., time) \tag{3}$$

The following second order polynomial (SOP) model was fitted to the data. Two models of the following form were developed to relate two responses (Y):

$$Y_k = \beta_{k0} + \beta_{k1}X_1 + \beta_{k2}X_2 + \beta_{k11}X_1^2 + \beta_{k22}X_2^2 + \beta_{k12}X_1X_2 \tag{4}$$

where: β_{kn} are constant regression coefficients; Y, either rehydrations of sugar beet molasses solution treated samples (Y_1), and rehydration of NaCl+sucrose solution treated samples (Y_2); X either rehydration time (X_1), and temperature (X_2). The significant terms in the model were found by analysis of variance (ANOVA) for each response.

Statistical analysis and verification of the experiments

Analysis of variance (ANOVA) and response surface regression method (RSM) were performed using StatSoft Statistica, for Windows, ver. 10 program. The model was obtained for each dependent variable (or response) where factors were rejected when their significance level was less than 90%. The same program was used for generation of graphs and contour plots.

The graphs of the responses with significant parameters were superimposed to determine optimum drying conditions, plotted on optimization graphic. After the optimum conditions were established, separate experiments were performed for model validations of the models.

3. RESULTS AND DISCUSSION

The study was conducted to determine the rehydration conditions (rehydration ratio and volume changes) for pork meat cubes. The experimental data used for the analysis were derived from the Box and Behnken's 2 level-2 parameter design. Tab. 1 shows the response variables as a function of independent variables for the analysis.

The analysis of variance (ANOVA) tables exhibits the significant independent variables as well as interactions of these variables. In this article, ANOVA showed the significant effects of independent variables to the responses and which of responses were significantly affected by the varying treatment combinations (Table 2). It shows the ANOVA calculation regarding response models developed when the experimental data was fitted to a response surface. The response surface used a second order polynomial in the form of eq. (4) in order to predict the function f_k, eq. (3) for all dependent variables.

Sugar beet molasses treated samples were significantly affected by all process variables, temperature and treatment time, at 95% confidence level. It was noticed that rehydration was most affected by linear term of processing temperature. The impact of temperature was dominant, as seen by temperature's quadratic term, and also the cross-product term, which were more influential then both rehydration time linear and quadratic term. The rehydration time quadratic term is significant at 90% confidence level.

NaCl+sucrose treated meat samples rehydration were most affected by linear term of processing temperature (significant at 95% confidence level). The quadratic terms for both temperature and rehydration time were found statisticaly insignificant, while cross product of rehydration time and temperature was found more influential then the linear term of rehydration time. Both of these terms were significant at 95% confidence level.

Sugar beet molasses treated samples volume change were significantly affected by cross product of temperature and processing time, and quadratic term of temperature, significantly at 90% level, while linear term affects volume change statistically significant at 90% level. All other sources were statistically insignificant. The temperture terms were found dominant, but mostly non-linear, which can be observed on the contour plots.

NaCl+sucrose treated meat samples volume change were most affected by linear and quadratic terms of processing time (significant at 90 and 95% confidence level, respectively). The quadratic term of temperature and cross product term was found statisticaly significant at 95% level, while all others terms were found statistically insignificnt.

Table 2. ANOVA table

Term	Source	R of sugar beet molasses trated samples	R of NaCl+ Sucrose trated samples	dV of sugar beet molasses treated samples	dV of NaCl+ Sucrose terated samples
Linear	Temp	1543.020*	1680.341*	26.873 **	0.029^{ns}
	t	39.412*	61.962*	5.074^{ns}	49.671**
Quadratic	Temp	55.845*	0.504^{ns}	160.379*	163.464 *
	t	9.117**	2.231^{ns}	2.576^{ns}	138.729*
Cross product	Temp x t	66.196*	124.950*	357.289*	158.027*
Lack of fit	Error	14.324^{ns}	5.256^{ns}	30.459^{ns}	8.300^{ns}
r^2		99.171	99.720	91.467	93.665

*Significant at 95% confidence level, **Significant at 90% confidence level, ^{ns}Not significant

The analysis revealed that the linear terms for rehydration contributed substantially in all cases to generate a significant SOP model. The SOP models for all variables were found to be statistically significant and the response surfaces were fitted to these models. The linear terms of SOP model were found significant, at 95% confidence level, and their influence were found most important in model calculation. On the other hand, non-linear terms in the SOP model for volume changes were found dominant, which is due to complexity of observed system.

Also shown in Table 2 is the residual variance where the lack of fit variation represents other contributions except for the first and second order terms. A significant lack of fit generally shows that the model failed to represent the data in the experimental domain at which points were not included in the regression. All SOP models had insignificant lack of fit tests, which means that all the models represented the data satisfactorily.

The coefficient of determination, r^2, is defined as the ratio of the explained variation to the total variation and is explained by its magnitude (*Madamba P. S, et. al., 2002*). It is also the proportion of the variability in the response variable, which is accounted for by the regression analysis (*Madamba P. S, et. al., 2002*). A high r^2 is indicative that the variation was accounted and that the data fitted satisfactorily to the proposed model (SOP in this case). The r^2 values for rehydration of sugar beet molasses treated sample (99.171) and rehydration of NaCl+sucrose treated sample (99.720) were very satisfactory and show the good fitting of the model to experimental results. Volume changes of sugar beet molasses treated sample (91.467) and NaCl+sucrose treated sample (93.665) showed less confident model results, but also the good fitting of the model and the experimental results.

Table 3 shows the regression coefficients for the response SOP models of rehydration and volume changes of sugar beet molasses and NaCl+sucrose treated samples, used by eq. (4) for predicting the values. The contour plots developed from the approximating function rehydration and volume change, of sugar beet molasses and NaCl+sucrose treated samples are shown on Fig. 1 and 2, respectively. Both rehydration of sugar beet molasses and NaCl+sucrose treated samples contour plot showed a saddle point configuration, and its value minimized to the upper right corner of the plot, with the increase of all process variables, temperature an treatment time. Volume changes of sugar beet molasses treated samples showed minimum configuration and NaCl+sucrose treated samples contour plot showed a maximum point configuration.

Table 3. Regression coefficients

Term	Source	R of sugar beet molasses trated samples	R of NaCl+ Sucrose trated samples	dV of sugar beet molasses treated samples	dV of NaCl+ Sucrose terated samples
Interchange		-2,27±4,83^{ns}	7,28±2,92*	-45,02±18,93**	-49,04±14,99*
Linear	Temp	0,54±0,20*	-0,20±0,12^{ns}	2,21±0,79*	2,06±0,62*
	t	0,74±0,16*	0,75±0,10*	0,91±0,65^{ns}	1,54±0,51*
Quadratic	Temp	-0,01±0,00*	-0,00±0,00^{ns}	-0,02±0,01**	-0,02±0,01*
	t	-0,01±0,00^{ns}	-0,00±0,00^{ns}	-0,00±0,01^{ns}	-0,02±0,01*
Interaction	Temp x t	-0,01±0,00*	-0,01±0,00*	-0,02±0,01*	-0,01±0,01*

*Significant at 95% confidence level, **Significant at 90% confidence level, ^{ns}Not significant

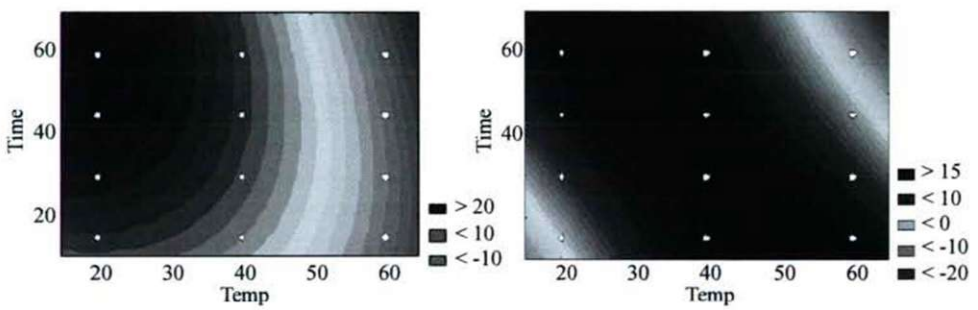
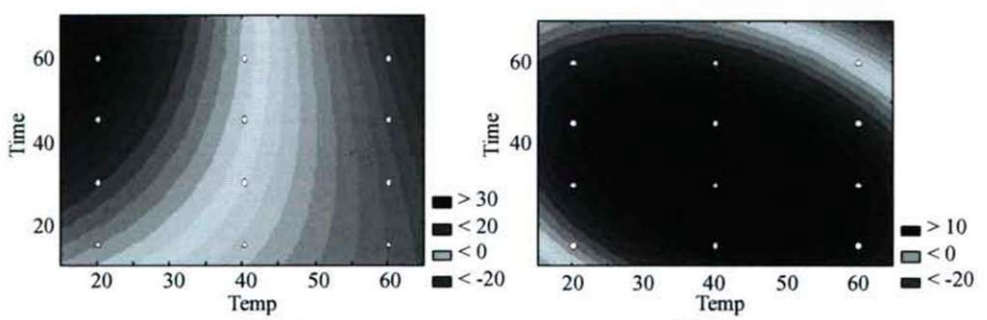


Figure 1. Contour plots for rehydration and volume changes of sugar beet molasses solution treated pork meat Figure 1. Contour plots for rehydration a) and volume changes b) of sugar beet molasses solution treated pork meat cubes as function of temperature and time



a) ***b)***

Figure 2. Contour plots for rehydration a) and volume changes b) of NaCl + sucrose solution treated pork meat cubes as function of temperature and time

Maximum rehydration is achieved when processing time rises, while temperature is relatively low, for both sugar beet molasses and NaCl + sucrose treated meat cubes, while volume changes seem to gain their maximum with mild temperatures and relatively low processing time, close to the center of contour plot. It seems that the upper left corner of contour plots showed on Fig.1 and 2, could produce an processing optimum, concerning low energy consumtion, with long processing time, but also good rehydration percentage, and increase of sample volume. Upper right processing conditions should be avoided, due to high energy cost, and also degradation of pork meat cubes structure. The rehydration results were also unexeptable, as seen from Table 1.

To determine the adequacy of the SOP models, independent experiments were performed at chosen processing condition (rehydration temperature 40°C and processing time 45 minutes) for validation (*Madamba P. S, et. al., 2002*). Table 4 shows the model validation results. As shown in the previous ANOVA tables, the predicted values were comparable to the actual values in the experiment. Very good coefficients of variation (CV) of less than 10% for all process variables were calculated. CV values higher than 15% for response variables show great influence to the statistically minor significance of its SOP model (*Madamba P. S, et. al., 2002*). The low CV values for response variables for rehydration of sugar beet molasses and NaCl+sucrose indicated the adequacy of these models.

Table 4. Predicted and observed responses at optimum conditions

Rehydration	Predicted	Observed	Standard deviation	Coeff. of variation
R, sugar beet molasses	12.542	12.679	0.041	0.323
R, NaCl+ Sucrose	5.432	5.447	0.263	4.826
dV, sugar beet molasses	16.218	15.989	0.694	4.340
dV, NaCl+ Sucrose	15.953	16.013	0.563	3.515

4. CONCLUSION

The wide variety of dehydrated foods, which today are available to the consumer (snacks, dry mixes and soups, dried fruits, etc.) and the interesting concern for meeting quality specifications and conserving energy, emphasize the need for a thorough understanding of the operation and the problems related to the design and operation of dehydration and rehydration plants. The knowledge of physicochemical properties of food materials is important for an adequate design of food operations as well as for the control and improvement of the quality of the final product.

Food shape is one of the main quality attributes perceived by the consumer. Drying not only causes volume changes but also may cause changes in shape. In this sense, product deformation is not fully described by the evaluation of volumetric shrinkage. Mathematical models of dehydration and rehydration operations are important in the design and optimisation of those operations.

The RSM algorithm was used to model the rehydration and volume change of pork meat cubes after osmotic dehydration in sugar beet molasses and NaCl+sucrose solutions.

SOP models for all system responses were statistically significant while predicted and observed responses correspond very well.

Sugar beet molasses treated samples were significantly affected by all process variables, temperature and treatment time whereas the NaCl+sucrose treated meat samples rehydration were most affected by linear term of processing temperature. In terms of volume change, in case of sugar beet molasses treatment, volume changes were significantly affected by cross product of temperature and processing time, and quadratic term of temperature; while NaCl+sucrose treated meat samples volume changes were most affected by linear and quadratic terms of processing time.

Rehydration is most effective with the time increase at relatively low temperatures, for both cases of dehydration in sugar beet molasses and NaCl+sucrose solution. Volume change has its maximum at mild temperatures and at relatively low processing time.

ACKNOWLEDGEMENT

This work is part of project „Osmotic dehydration of food - energy and environmental aspects of sustainable production", project number TR-31055, financed by Ministry of Education and Science Republic of Serbia.

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EFFECT OF INFORMATION ON THE RISK PERCEPTION OF FOOD ADDITIVES – A QUANTITATIVE SURVEY IN HUNGARY, SPAIN AND ROMANIA

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ABSTRACT

Consumers might feel aversion to food additives due to unreliable and controversial information received and their low level of knowledge.
The aim of our study was to evaluate the judgement and acceptance of different groups of food additives before and after providing information in three European countries (Hungary, Spain, and Romania).

For this purpose a self-administered questionnaire was developed and filled out via Internet in the three countries. 437 completed questionnaires were collected in Hungary, 348 in Spain and 386 in Romania. Data were analysed with SPSS 17.00 statistical software.
The following food additive groups were perceived as the most hazardous ones: "preservatives" in Hungary, "bulking agents" in Spain and "colourings" in Romania. However as the less hazardous group "antioxidants" was indicated in the countries. After providing specific information Hungarian and Romanian respondents showed more positive opinion about the listed groups of food additives, while Spanish participants did not at all. When natural and artificial food additives were analysed separately it was observed that respondents confounded "antioxidants" with the nowadays popular healthy compounds – which have the same name –, because after information provided both the natural and artificial groups got more negative acceptance.

The findings of this study highlighted that the communication methods have to be adapted to the countries' characteristics. Consumers' confidence could be enhanced by better and more targeted information supply about the groups of food additives, furthermore in some cases the term "natural" could increase the level of acceptance.

1. INTRODUCTION

Consumers often have negative feelings about food additives which are probably due to the incomplete and not specific information. In our questionnaire survey it was found that respondents reported high level of knowledge about food additives (Hungary: 87.6%, Romania: 92.5%, Spain: 84.2%). However when detailed knowledge was analysed, this was not detected as far as mixed and ambiguous level of knowledge was detected. Members of the Hungarian survey reported the highest level of detailed knowledge, while Spanish respondents the lowest. 89.1% of the Romanian participants and 81.7% of the Hungarian respondents knew properly that "Food additives are not consumed in themselves, just added to foodstuffs" while just 64.7% of the Spanish ones thought the same. 70.7% of the Hungarian participants were aware of the statement that "Preservatives are food additives" while 64.5% of the Romanian and 61.2% of the Spanish respondents knew it well. Our hypothesis was that appropriate information could reduce the uncertainty and could increase the acceptance of the different groups of food additives, thus questions were developed and inserted into the above-mentioned questionnaire.

2. MATERIALS AND METHODS

A self-administered questionnaire was developed in 2009 in Hungary, in which participants were asked to judge the level of hazard of different groups of food additives on a 1-5 Likert scale (1: not hazardous at all, 5: really hazardous), respectively. Following the analysis of the results of 400 filled questionnaires a concise and more targeted questionnaire was designed. Some groups of food additives were excluded, mainly those where participants could not evaluate exactly the level of hazard, thus the rate of "do not know" answers were too high (e.g. "sequestrants" (41%) and "anti-caking agents" (19.5%)).

In the concise questionnaire respondents first were asked to judge the level of hazard of different groups of food additives on a 1-5 Likert scale (see above). Later on in another question some information was provided about the same additive groups (short definitions with examples, e.g. "Preservatives are substances which prolong the shelf life of foodstuffs by protecting them against deterioration caused by micro-organisms (e.g. sorbic acid in dried fruits and sodium-nitrate in cured meat products") and participants were asked to evaluate their acceptance (1: absolutely accept, 5: absolutely reject). Definitions of the "European Parliament and Council Directive No 95/2/EC on food additives other than colours and sweeteners" were used. In some cases ("antioxidants", "colourings" and "sweeteners") the acceptance of artificial and natural groups was detected separately.

The questionnaire was translated into Spanish and Romanian, too and filled out in Hungary and Romania via Internet and on paper (N= 200) and via Internet in Spain. Altogether 437 fully completed questionnaires were collected in Hungary, 348 in Spain and 386 in Romania. Results were collected in 2011 (Hungary: spring-summer, Spain: summer-autumn and Romania: autumn-winter). Data were analysed by the SPSS 17.00 statistical software.

3. RESULTS

3.1 Level of hazard before providing information

On the basis of the respondents judgement the most hazardous food additive groups were different in the three countries, "preservatives" in Hungary, "bulking agents" in Spain and "colourings" in Romania. "Bulking agents" resulted amongst the three most hazardous groups in all countries. However the less hazardous food additive group was "antioxidants". Favourable judgement of "antioxidants" was probably due to the fact that respondents confused this food additive group with the nowadays popular healthy food components. "Packaging gases and propellants" proved to be a really hazardous food additive group for Romanian participants, significantly ($p \leq 0.001$) more hazardous than for Hungarian and Spanish respondents. Results showed that Hungarian participants felt the biggest difference between the listed risk factors, while Spanish respondents the smallest (Table 1).

Table 1. Judgement of different groups of food additives (1: not hazardous at all, 5: really hazardous)

Food additives	Hungary	Spain	Romania
Antioxidants	1.86	2.19	2.17
Acids	2.55	2.86	3.96
Acidity regulators	2.76	2.76	3.76
Gelling agents	2.82	2.83	3.81
Sweeteners	3.07	2.83	3.85
Packaging gases and propellants	3.19	3.36	4.07
Raising agents	3.36	3.13	3.79
Flavourings	3.50	3.06	4.18
Bulking agents	3.36	3.45	4.16
Colourings	3.64	3.12	4.39
Preservatives	3.68	3.06	3.73

3.2 Level of acceptance after providing information

3.2.1 Groups of food additives

After providing information according to the participants the most hazardous groups were "artificial colourings" in Hungary and in Romania, while "bulking agents" still remained in Spain. "Natural antioxidants" was considered as the less hazardous group by the Hungarians and Romanians surveys, and "natural colourings" according to the Spanish respondents. Due to the provided information, acceptance of the listed groups of food additives was significantly ($p \leq 0.001$ or $p \leq 0.05$) higher – except of "antioxidants" – than previously in Hungary and Romania. Spanish participants showed significantly ($p \leq 0.05$) higher acceptance level in case of some groups like flavourings and gelling agents, however significantly ($p \leq 0.001$ or $p \leq 0.05$) lower regarding e.g. "preservatives" and "acids". "Packaging gases and propellants" got significantly ($p \leq 0.001$) higher acceptance after the information providing in the three countries and in Hungary its' level of acceptance was still significantly ($p \leq 0.001$) higher than in Spain and Romania.

Table 2. Acceptance of different groups of food additives (1: absolutely accept, 5: absolutely reject)

Food additives	Hungary	Spain	Romania
Natural antioxidants	2.03	2.26	2.26
Artificial antioxidants	3.10	3.25	3.04
Natural colourings	2.07	2.14	2.34
Artificial colourings	3.26	3.19	3.07
Natural sweeteners	2.21	2.37	2.32
Artificial sweeteners	2.83	3.07	2.83
Acids	2.28	2.74	2.71
Preservatives	2.45	2.38	2.58
Packaging gases and propellants	2.59	3.08	2.90
Gelling agents	2.59	3.11	2.58
Acidity regulators	2.61	2.92	2.77
Raising agents	2.85	3.20	2.83
Bulking agents	2.98	3.42	3.01
Flavourings	3.14	3.31	3.02

The acceptance of "antioxidants" – both artificial and natural – was lower after providing information in the countries concerned, so it was obvious that participants

previously confounded it with the healthy components. In all cases when the acceptance of artificial and natural groups was analysed separately, natural ones got significantly ($p \leq 0.001$) higher acceptance than the artificial ones (Table 2).

3.2.2 Effect of "natural" and "artificial"

In order to transform consumers' judgements into distances and to provide a visual representation of the plots' proximities a multidimensional scaling was done.

Hungarian participants had significantly more negative attitude regarding natural ($p \leq 0.05$) and artificial ($p \leq 0.001$) "antioxidants" after the provided information. Thus it can be said that they mistook "antioxidants" as food additives for the group of healthy components. The opposite tendency was observed in case of "colourings" (natural and artificial ≤ 0.001) and "sweeteners" (natural $p \leq 0.05$, artificial $p \leq 0.001$). "Antioxidants" got the highest acceptance amongst the natural food additives, while "sweeteners" the lowest (significantly lower than "antioxidants" ($p \leq 0.001$) and "colourings" ($p \leq 0.05$)). "Artificial colourings" was significantly ($p \leq 0.001$) the most accepted artificial food additive group in contrast to "antioxidants" and "sweeteners" (Figure 1).

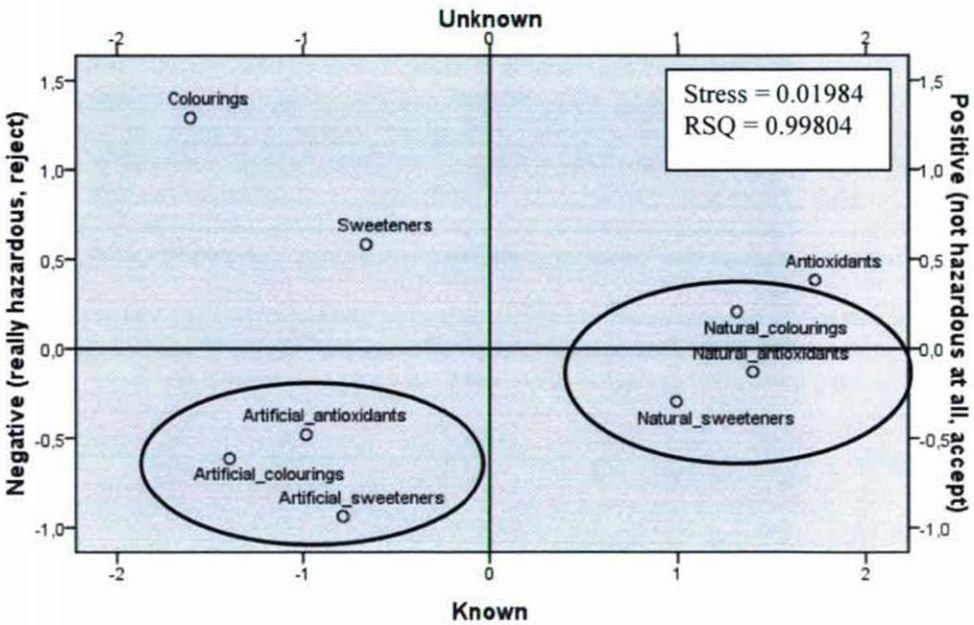

Figure 1. Effect of information on the acceptance – Hungary

"Artificial and natural antioxidants" were significantly ($p \leq 0.001$) more negative after the provided information according to the Spanish participants. "Natural sweeteners" and "natural colourings" got significantly ($p \leq 0.001$) more positive evaluation after the information supply, while their artificial pairs got more negative feedbacks ("artificial sweeteners" $p \leq 0.05$). Within the group of natural food additives' acceptance significant ($p \leq 0.001$) difference was found between "colourings" and "sweeteners". Regarding artificial additives "sweeteners" got significantly ($p \leq 0.05$) lower level of acceptance than "colourings" and "antioxidants" (Figure 2).

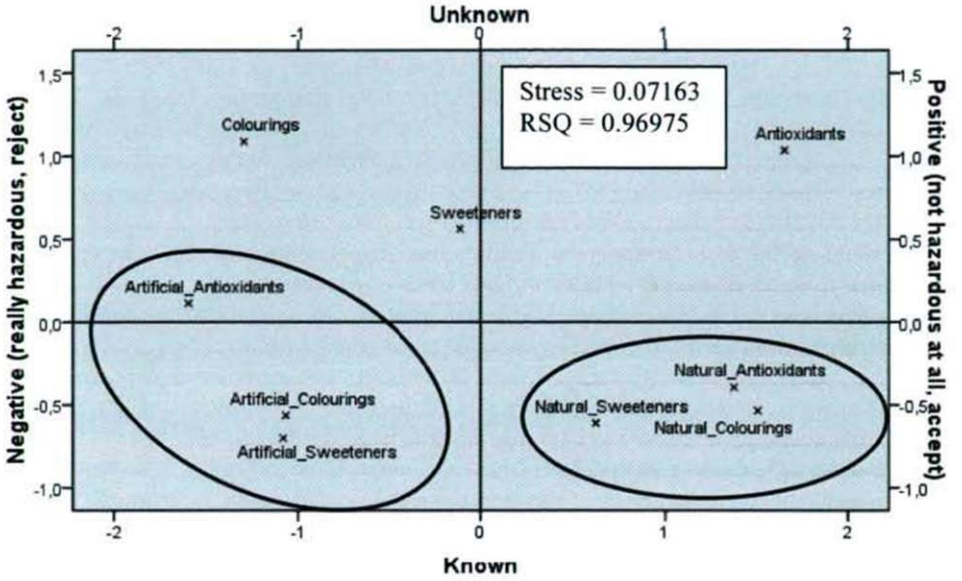

Figure 2. Effect of information on the acceptance – Spain

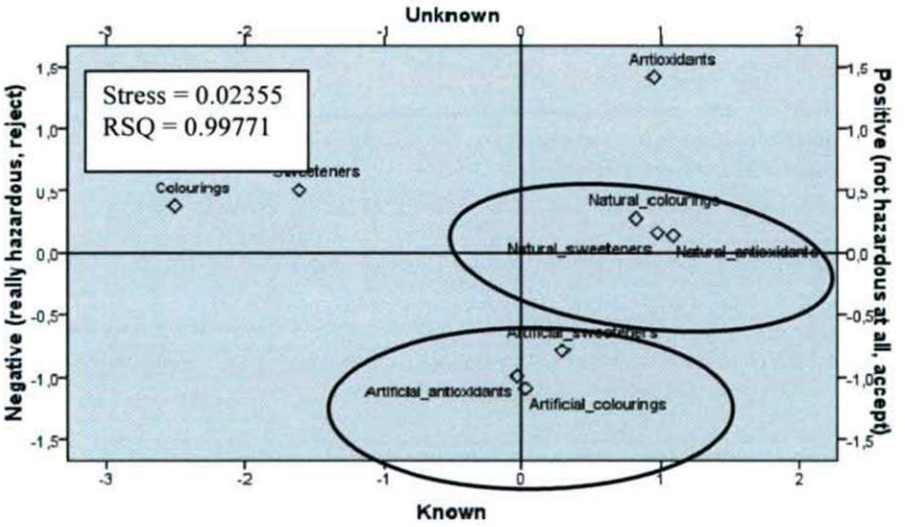

Figure 3. Effect of information on the acceptance - Romania

As it was observed in Hungary, Romanian respondents also gave significantly ($p \leq 0.001$) more negative evaluation to "natural and artificial antioxidants" after the provided information, while "natural and artificial sweeteners" and "colourings" got significantly ($p \leq 0.001$) higher values. Amongst natural food additives Romanian participants did not found significant differences. In case of artificial additives "sweeteners" got significantly ($p \leq 0.001$) higher acceptance than "antioxidants" and "colourings".

4. CONCLUSIONS

The judgement of the listed groups of food additives was different, nevertheless "antioxidants" was judged as the less hazardous group in all three countries. This favourable judgement was due to the fact that it was probably confounded with the healthy compounds. After providing information more negative opinion was expressed about natural and artificial antioxidants.

The provided information had different effects on the acceptance of the different groups of food additives. Hungarian and Romanian respondents showed a more positive opinion, while Spanish participants did not in any cases.

When natural and artificial food additives were analysed separately, Hungarian and Romanian respondents were more positive regarding both, while participants from Spain only with the natural ones. Hungarians showed significant differences between the acceptance of the elements of artificial and natural groups, while Spanish participants only in some cases and Romanian ones found differences only amongst the artificial food additives.

The observed level of hazard was different in the three countries and the provided information had different effect on the acceptance of food additive groups, thus our hypothesis was not confirmed unambiguously. Although members of the Hungarian and Romanian surveys showed certain similarities, results of this study highlighted that the communication methods have to be adapted to consumers' attitudes, knowledge and to the specialities of the given countries' social and cultural character. On the basis of the results of this quantitative survey it was found that consumers' confidence could be enhanced with better and more targeted information about food additives, furthermore in some cases the term "natural" could increase their acceptance.

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EFFICIENCY OF THE EXTRUSION PROCESS OF THERMOPLASTICS MODIFIED WITH BLOWING AGENT

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ABSTRACT

Extrusion process is one of the most popular polymer processing method. It allows to produce different types of shapes e.g. pipes, cables, plates, nets, films, coating, bars. This kind of shapes are usually made from typical thermoplastics materials like PVC, HDPE, LDPE, PP, PS, which characterizes solid physical structure. Nowadays, the most popular processing method is modification of plastic material with different types of agents. The modification consists of adding auxiliary agents takes place through the introduction of these materials during plastic processing or directly in its production. These measures include the modifiers primarily to improve physical toughness, thermal formability or ductility. It could be flame retandant agent, flow agent, stabilizing agent, curing agent, filler, release agent, nucleant agent and blowing agent (porophor).

The growing interest in porous plastic materials and their means of production led to the formation of a new method of processing, which is the microcellular extrusion process. This extrusion method of thermoplastics in recent years is one of the fastest growing methods of polymer processing. The aim is to obtain different microporous shapes and coatings with reduced density, without subsidence on the surface of extrudate and exhibiting minimal shrinkage while maintaining the similar nature of the products of extruded by a conventional method.

Continuous development of microcellular extrusion process and the design elements comprising the technological lines creates new opportunities for research.
Article presents a study of microcellular extrusion process and its efficiency during modification with blowing agent in the form of microspheres.

1. INTRODUCTION

The extrusion process of microcellular thermoplastic is the subject of scientific research, yet little developed, the results have been presented only in few publications. This process is in recent years, one of the fastest growing methods of processing these materials. Its aim is to obtain profiles and microporous coatings with reduced density and subsidence at the surface without marc and exhibiting minimal shrinkage, while maintaining similar properties to the extruded products by a conventional method. Microcellular extrusion process consists in adding to the input material the blowing agent, a gas, which under appropriate conditions of the extrusion process is expanded, and increase its size several times.

As a result of processing a received product have two-phase structure, changed from the solid to microporous. The new structure of the material can be microporous throughout its cross section or have a solid outer layer and a microporous core. To achieve this its important to enter the gas into the plastic in the suitable form and time. The formation of pores occurs in the last zone of the extruder plasticizing system [8].

Change in microstructure of the material takes place through appropriate selection of extrusion conditions, mainly temperature distribution in the various zones of the plasticizing unit and zones of extrusion head, as well as a result of construction machinery and tools used in this process [9]. The carefully selected input material, blowing agent and nucleant, the extrusion process conditions and design tools allow to obtain products of the new modified properties.

Important role in the microcellular extrusion process plays temperature in different zones of the extruder plasticizing system and extrusion head zones. Its value should be close to the distribution temperature of blowing agent, but must be chosen so that the blowing agent was decomposed in the relevant zone of plasticizing extruder. This increases the viscosity of the processed material, which prevents expansion of the gas contained in the material flowing through the extrusion head. Decrease or increase porosity of the product structure is done by gradual dosing of blowing agent and adjustment screw rotational speed of the extruder [1].
The stream of plastic with blowing agent is transported under pressure to the extrusion head. The value of this pressure should be large enough that the gas inside the porophor not be spun off as a separate phase in the stream of material. As a result of shear stress in flowing plastic material barrier separating the gas bubbles would be destroyed mechanically. Plastic pressure grows extensively in the plastic along the extruder plasticizing system, slightly declining in the last part of the first zone and the boring head and then drops sharply at the nozzle head, up to atmospheric pressure.

The gas pressure initially increases quite extensively, although it is much smaller than the pressure of the material, then more slowly until the end of the boring head nozzle and outside, where a sudden drop in pressure [3].

In the process of extrusion profiles and coatings, shape and dimensions of the cross section gives a pre-brewing extrusion head, taking into account the effect of shrinkage Barus phenomena and processing, but it is not yet stable system. In order to obtain a uniform micro-brewing, devoid of micropores and external surface of the required size and shape, it becomes necessary to perpetuate it through the rapid cooling and solidification in the process of calibration [5].

Used in the microcellular extrusion process lines calibration device are designed to cool the residue to such a temperature that ensures the stability of shapes and sizes. The selection of calibrator determines the calibration method, a solution, design and method of cellular process. Internal calibration involves performing a open cross-section of extrudate after cooling the calibrator rod of a certain diameter and length and with a suitable clamp. Marc for the stem clamp calibration is due to contraction during cooling of extrudate. However, during external calibration of the extrudate after leaving the extrusion head is made by cooling sizing sleeve. As a result of the temperature difference between the extrudate and the surface of the cooling sleeve consolidation of the profile shape and dimensions takes place [7].

Microcellular extrusion process is applied during the manufacture of various types of shapes, in which there is a need for a significant reduction in the density of a product or change the selected physical properties, especially mechanical or utilitarian bagasse [1, 3, 8].

1.1. Microcellular extrusion methods

Depending on the structure of the resulting extrudate divided into the following microcellular extrusion method [2]: free cellular method, inside cellular method, partial cellular method, co-extrusion cellular method.

During free cellular method the entire cross section of extrudate have a porous structure, whose growth is limited by the cooling profile. This is due to the considerable distance between the extrusion head a calibrating device. As a result, this method produced extrudates are cellular in the whole section of product. With this method it is necessary to use a boring head nozzle with smaller cross-section relative to the channel cross-section of the calibrator.

Extrusion conducted by the inside cellular method, is also called a method Celluka. In this method, followed by intensive cooling of extrudate in the calibrator over its entire surface immediately after leaving the nozzle. This is to give the desired shape of extrudate by inhibiting proliferation of blowing agent and to avoid the formation of porous structure on the profile surface. As a result of this method the porous extrudate with solid outer layer is obtained. During cellular extrusion by inside method the external dimensions are identical between the nozzle exit from the boring head and the entrance to the device calibration. The intensity of cooling in this case determines the thickness of the surface layer of solid extrudate, because during this process on the surface do not form pores. By contrast with the free cellular method pore growth is increased by a greater distance between the extrusion head and a calibrator.

Preparation of porous extrudate is also possible through a combination of methods porowania free and Celluka. This method is called partial cellular method and allows the extrusion of sections with the outer layer partially solid. In this case, extensive cooling of extrudate occurs in a particular part of it, while the remainder is freely pore [10].

Foaming extrusion process may also be made using the co-extrusion cellular method. It enables the production of multilayer profiles, in which one layer is porous and the remaining solid. This process is carried out on standard lines, boring, but the need is to equip them with special heads, boring and longer calibration. The thickness of the solid outer layer of the resulting extruder head design can be adjusted, namely by moving the nozzle in the direction of one of the extrudate surface increases the intensity of cooling of the surface, therefore, the outer layer is formed thicker solid.

Depending on the cellular extrusion method used and the amount of blowing agents, extruded shapes and porous coatings have different properties. The products obtained by the inside method have higher hardness, resistance to light and atmospheric conditions and surface roughness. Whereas the elements produced by free method may have a greater degree of porosity.

1.2. Blowing agents

In order to properly carry out the microcellular extrusion process is important the proper selection of blowing agents. Type of porophor determines its decomposition temperature, material processed and the processing conditions. It is important that the temperature distribution of blowing agents was higher than the melting point of the material being processed, but lower than the temperature of extrusion of the this material. A further criterion for the selection of blowing agents is the method of processing and machinery and equipment used in the selected process. Porous material in a plastic state, as found in the plasticizing extruder and extrusion head is not yet stable system, as a result of surface tension at the interface: material - gas and diffusion, reducing the number of pores in the material, but increase their sizes what is the undesirable result. The resulting pores increase in time to reach a balance between gas pressure and surface tension of the processed material. The preferred structure of the material with small pores, it acts in the final formation by cooling as quickly as possible. Blowing agents are in the process of extrusion of the same factors as the material being processed, it is heating, compression, homogenized, and transportation, even before the passage of gas. Inert gases and low boiling liquids may be subject to dissolution in the plasticised material, with the blowing agent dissolution rate increases with increasing mixing intensity and gas pressure.

Blowing agents applicable in the extrusion process, is divided into traditional, though not too closely, the physical and chemical [3]. This division shall be carried out because of the

way of gas evolution. Physical blowing agents during the cellular process not change its chemical structure, but only the state. They are, therefore, liquids or gases dissolved under pressure in the material, which after raising the temperature and lowering the pressure evaporate or emit in the form of bubbles. To this group belong to organic liquids of low boiling point: primarily aliphatic hydrocarbons and chlorofluorocarbons them. Chemical blowing agents operate in a similar way as physical blowing agents, but the gaseous products resulting pores are formed from the decomposition of the material. They are divided into inorganic and organic.

Porophors used during the cellular process may have exothermic or endothermic decomposition characteristics [6]. But so far used in the extrusion process are exothermic blowing characteristics of the distribution. This can cause local overheating and the formation of an irregular porous structure of the product. Started blowing agent decomposition takes place spontaneously, even after cutting off the supply of energy. Therefore, the products of this type of porous measures must be cooled to prevent distortion and maintain proper pore structure. The main representatives of this group are hydrazides for example sulfohydrazyd and azo compounds such as azodicarbonamide.

In the case of the porophors with endothermic nature of the distribution, the gas expansion during processing ends abruptly at the end of the energy supply. The use of such blowing agents significantly reduces cooling time of the product. Representatives of this group are among bicarbonates, for example, sodium bicarbonate and ammonium acid.

At present was introduced to the market a new blowing agent in the form of polymer capsules called microspheres, filled with gas from a group of hydrocarbons, such as isobutane, isopentane, isooctane. The microspheres are endothermic nature of decomposition, the thermal energy charge for plasticizing the capsule and the change of state from liquid hydrocarbon in volatile. Under the influence of a certain temperature microspheres increase in size about 50 times. The microspheres form a microporous structure, providing a lower density of extrudate while retaining microscopic cells, closed and homogeneous in size. Microspheres by weight of a product offer tangible economic benefits, also modify other properties, such as susceptibility to compression, the ability to recover the original shape of a product, absorbing vibration and electro-beneficial properties and thermal insulation. The spherical shape is one of the unique features that distinguish this agent from other porophors [4].

During the growth of the barrier properties of the microspheres act to prevent the leakage of gas and a combination of individual capsules with each other. There are several types of microspheres, which are selected depending on the range of processing temperatures and dimensions of the microspheres after expansion.

2. EXPERIMENTAL

Modified PVC extrusion process was conducted in a laboratory extrusion technological line of the shapes in the Department of Polymer Processing, Lublin University of Technology. During the process single-screw extruder T-32-25, provided with a core extrusion head with bar extrusion nozzle was used. The process was performed by free cellular method in order to obtain the free and the maximum growth of microspheres in PVC. Extrusion process was carried out in the revised processing conditions (Table 1) developed on the basis of preliminary studies.

As the input plastic the plasticized PVC Alfavinyl GFM/4-41 TR was used. The plastic was modified with blowing agents in the form of microspheres Expancel 930 MB 120

which is a mixture of microspheres (65%) and EVA copolymer. Blowing agent was dosed at levels from 0% to 2.5% (at 0.5%).

Process was carried out by changing the screw rotating speeds for each content of blowing agent.

Table 1. Processing conditions of plastified PVC modified with blowing agent

Zones of plasticizing system and extrusion head	I	II	III	IV	V
Processing temperature of solid PVC, °C	120	130	140	150	160
Processing temperature of PVC with blowing agent, °C	100	110	120	130	140
Screw rotational speed, rpm	45	61	78	94	111

3. RESULTS

As a result of a modified PVC extrusion process with blowing agent residue in the form of a rod with a diameter of 8 mm was obtained. Physical structure of extrudate was microporous throughout its cross section and characterized by different porosity depending on the used variable factors. An example of the appearance of the structure of the resulting extrudate is shown in Figure 1.

Figure 1. Physical structure of microcellular PVC extrudate with 2.5% content of blowing agent extruded with 78 rpm of screw rotational speed

In the course of the extrusion of PVC modified with microspheres of measurements of mass of measuring length, time of extruded measuring length and the temperature of of the extrudate leaving the extrusion nozzle head were performed. They allowed to determine the mass and volumetric flow rate of extrudate from the extrusion head, Barus phenomena and distribution of temperature on the surface of the microcellular extrudate obtained.
Selected results of the modified PVC extrusion process with blowing agent in the form of diagrams was presented on Figures 2÷5.

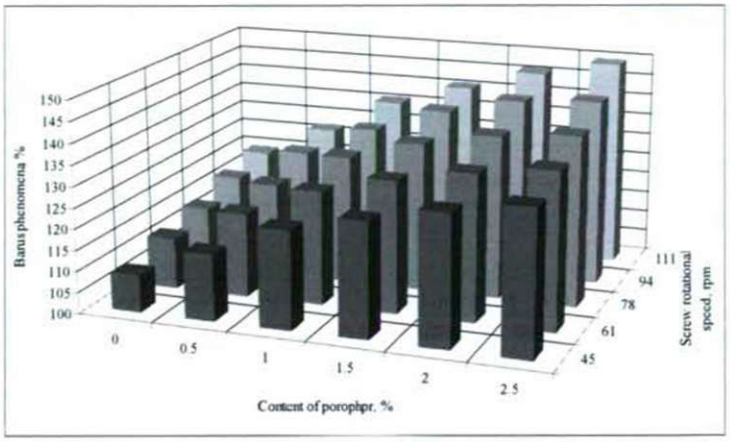

Figure 2. Dependence of Barus phenomena of microcellular PVC extrudate on content of blowing agent and screw rotational speed

The measure of Barus phenomena is the Barus number. Its value has increased in direct proportion with the increase of screw rotational speed regardless of the means of blowing agent. This value also increases gradually and steadily with increasing content of porohor from 0% to 1.5% by mass. After exceeding this value is observed decrease of the Barusa number, which may be due to a weaker expansion of the microspheres in the process, due to the large amount dispensed blowing agent.

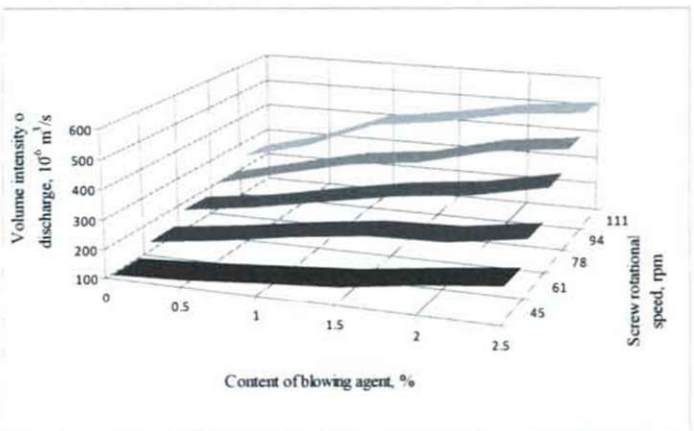

Figure 3. Dependence of volume intensity of discharge of extrudate on content of blowing agent and screw rotational speed

In the whole range of increasing screw rotational speed and increasing the blowing agent dosage, significantly increases the volumetric flow rate of extrudate from extrusion head. At the lowest rotational speed equal to 45 rpm value of the intensity of the solid material (0%) is 100 10-6 m3/s, while the dosage of microspheres in an amount of 2.5 % increases up to 219 10-6 m3/s. The results showed that the intensity of the bands at fixed screw rotational speed rate is directly proportional to the screw rotational speed and increases with increasing the content of the blowing agent in the polymer material. This increase is

more intense, while increasing the rotational speed of the screw and increases the amount dispensed porophor.

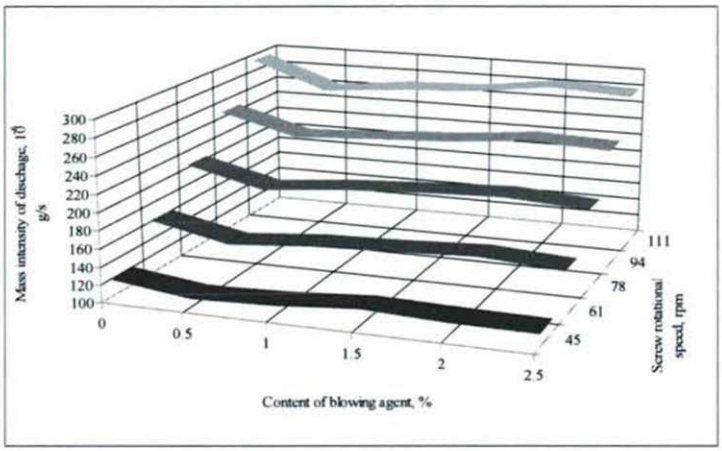

Figure 4. Dependence of mass intensity of discharge of extrudate on content of blowing agent and screw rotational speed

Mass flow rate of extrudate in assistive technologies etc. depends on both the content of blowing agent and the screw rotational speed. At the same time examined the relationship changes slightly in the permitted ranges of values of variable factors. Obtained results bagasse mass flow rate of PVC modified with microspheres showed that the intensity is greater changes under the influence of screw rotational speed increment. In each case considered, this effect is not as significant as the volume flow rate.

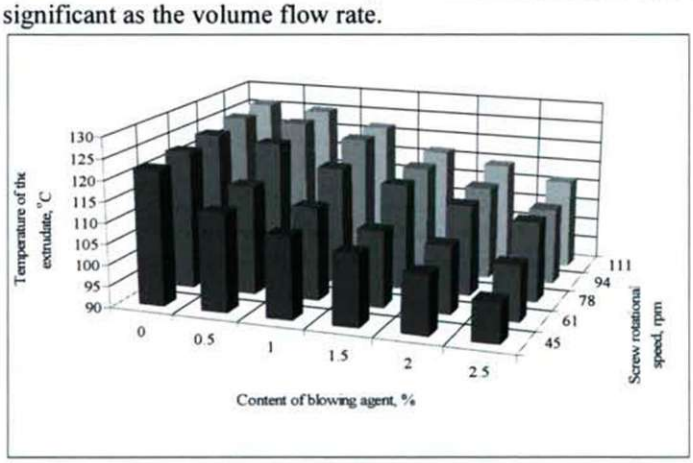

Figure 5. Dependence of temperature of microcellular extrudate on content of blowing agent and screw rotational speed

With increasing dosage of blowing agent center temperature of the material leaving the extrusion nozzle head has decreased, and in the dosage range investigated was a decrease of 15°C. At the same time it can be assumed that the greatest drop in temperature is observed using a dosage amount of 0.5% of blowing agent. When increasing porophor dosage of 1.5% above the masses. temperature of the extrudate was some stabilization at around 130°C. When

increasing the screw rotational speed above 78 rpm the temperature of extrudate increased for small content of porophor between 0.5 and 1 %. and its fall to the content above 1.5 % of microspheres.

4. CONCLUSIONS

PVC modification with the blowing agent in the form of microspheres resulted in significant changes in the extrusion process. The changes are caused by a fundamental change in the physical structure and a decrease in the extrudate density. Admitted to the study of the characteristics of the microcellular extrusion process allowed closer and more comprehensive knowledge of the impact of modifying material with the blowing agent in the form of microspheres on the course and efficiency of the process.

As the screw rotation speed and the content of blowing agent in PVC plasticized increases volumetric and mass flow rate of extrudate from the extrusion head, as well as the Barus phenomena. This increase is mainly due to hyperplasia of the microspheres, resulting in widening stream of material flowing from the extrusion head. Research microcellular extrusion of PVC modified with blowing agent in the form of microspheres showed a significant influence selection of the conditions of this process on its course. It is first necessary to determine the appropriate value and the temperature distribution in the system plasticizing system of the extruder and extrusion head, different than the extrusion of the same material but solid.

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EFFECT OF DIFFERENT CONDITIONS ON *SACCHAROMYCES CEREVISIAE* IMMOBILIZATION ONTO SUGAR BEET PULP IN ETHANOL PRODUCTION

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ABSTRACT

The use of yeast cells immobilized on sugar beet pulp as support for ethanol production employs a cheap and simple method of retaining high cells densities. The present work describes the effect of yeast concentration and ammount of support on immobilization of *Saccharomyces cerevisiae* onto sugar beet pulp (SBP). Further, the efficiency of immobilized biocatalyst for batch ethanol fermentation of sugar beet thin juice was investigated with goal to examine the optimum conditions of its potential application. The hydratet SBP showed highes cells retention capacity of 0.117 g/g. A maximum sugar conversion of 97.69%, ethanol concentration of 75.66 g/l, ethanol yield per consumed sugar of 0.499 g/g (equal to 97.71% of its theoretical value) was achieved in the batch fermentation of thin juice substrate. This study demonstrates that the efficient ethanol fermentation from sugar beet thin juice using *S. cerevisiae* immobilized by natural adhesion on sugar beet pulp (SBP) is possible even without any nutrient supplementation. The novelty of the approach lies in the effectiveness of exploitation of thin juice and sugar beet pulp with purpose to obtain efficient ethanol production from and to lower high operating cost.

1. INTRODUCTION

Recently, ethanol produced by alcoholic fermentation from sucrose, starch or lignocellulosic biomass has received special attention as the most promising biofuel from renewable resources. Ethanol is widely used as solvent and chemical feedstock in various industries (Sivakumar et al., 2010). Cell immobilization techniques have become increasingly important and are being successfully applied in production of alcohol (ethanol, butanol and isopropanol), organic acids (malic, citric, lactic and gluconic acids), enzymes (cellulase, amylase, lipase and others), and biotransformation of steroids for wastewater treatment, and food applications (beer and wine) (Reddy et al., 2008).Yeast cell immobilization on various plant materials in the ethanol fermentations has many technical and economical advantages compared to free cell system. It is an effective method for improving the efficiency of substrate utilization and productivities of fermentation processes (Kourkoutas et al., 2006). Our previous study of ethanol production by SBP-supported yeast cells showed increased ethanol efficiency in the ethanol production from sugar beet molasses and thick juice (Vučurović and Razmovski, 2012). Molasses is a traditional raw material for distilleries in Serbia, particularly in the Vojvodina province, and about 90% of ethanol production comes from this raw material nowadays. The production of bioethanol from thick juice as an intermediate of sugar beet processing by yeast cells immobilized onto sugar beet pulp gives the benefits of reduced water usage, reduced wastewater purification costs, easier mixing with syrup if used warm, lower use of acids for pH buffering, increased levels of nutrients and higher ethanol efficiency compared to molasses (Vučurović and Razmovski, 2012). However, the ethanol fermentation of sugar beet thin juice by *S. cerevisiae* immobilized onto the hydrated SBP was not investigated so far. The aim of this work was to explore the the effect of yeast concentration and amount of support on immobilization of *S. cerevisiae* onto sugar beet pulp (SBP). Further, the efficiency of immobilized biocatalyst for batch ethanol

fermentation of sugar beet thin juice was investigated with goal to achieve efficient ethanol production.

2. MATERIAL AND METHODS

Dried sugar beet pulp (SBP) from a sugar factory near the city of Senta in the Vojvodina province, Serbia was kindly provided and used as support for yeast cells. The SBP hydration was carried out by placing an amount of 10 g, 25 g and 50 g of DSBP on dry basis into 1 l Erlenmeyer flasks containing 500 ml of synthetic culture medium consisted of glucose (120 g/l), $(NH_4)_2SO_4$ (1 g/l), KH_2PO_4 (1 g/l), $MgSO_4$ (5 g/l) and yeast extract (4 g/l) at pH of 5.5, and was sterilized by autoclaving at 121°C for 30 min. After the sterilization, flasks were kept at room temperature for 24 h. Working microorganism was a commercial *S. cerevisiae* strain (Alltech-Fermin, Senta, Serbia), commonly used in Serbian baking industry, in form of pressed blocks (70 % w/w moisture). To immobilize cells on hydrated DSBP, the flasks were inoculated with 3 g/l, 4.5 g/l and 6 g/l of yeast on dry basis, and placed on a rotary shaker (120 rpm) in termostate at 30 °C for 24 h. After the immobilization of the yeast, the mass of immobized cells onto the support was quantified gravimetrically according to Santos et al. (2008). Cell retention onto the support (R, g/g) was calculated as the ratio of dry matter of cells immobilized in the support (g) to the support dry mass (g). Carl Zeiss optical microscope connected to a camera Cannon S50 was used to capture yeast cells immobilized onto hydrated SBP. After the immobilization of the cells, the medium was decanted using sterilized gauze. The suport without extra medium, was then dried at 105 °C up to constant weight. The identical procedure was conducted using support particles recovered from the cell-free medium, as a control, in order to avoid any interference in weighing measurements. The selected biocatalyst with highest cells retention (R) was used for the batch fermentation of 500 ml of the sugar beet thin juice in 1 l Erlenmeyer flask. Thin juice was obtained from the mentioned sugar factory. The total sugar content of thin juice was 155,53 g/l, pH was adjusted to 5.5 pH by addition of 10% (v/v) H_2SO_4 and it was sterilized by autoclaving at 121 °C for 30 min. The fermentation kinetics was monitored by measuring the weight loss due to CO_2 release at various time intervals from the beginning of each fermentation batch. Samples of fermented liquids were analyzed for ethanol and sugar. The fermented liquid was centrifuged at 3000 rpm for 15 min. The sample of supernatant was hydrolyzed in 33% HCl at 100 °C for 10 min and neutralized with NaOH solution, and sugars were than determined using the 3,5-dinitrosalicylic acid (DNS) method (Miller, 1959). The ethanol concentration of distillate was determined based on the density of the alcohol distillate at 20 °C, by pycnometer method (AOAC method 942.06, 2000). Sugar conversion ($S_{u,\%}$) was calculated as the ratio of utilized sugar to the initial and multiplying by 100. The ethanol yield ($Y_{p/s}$, g/g) was calculated as grams of ethanol produced per gram of utilized sugar. Also a percentage of the maximal theoretical ethanol yield ($E_{p/s}$, %) was calculated. The volumetric ethanol productivity (Q_p, g/lh) were calculated as grams of ethanol produced per liter per hour.

3. RESULTS AND DISCUSSION

The immobilization of *S. cerevisiae* on hydrated SBP is a result of natural entrapment into the porous structure of materials, which includes physical adsorption by electrostatic forces between the yeast cell membrane and the support and also the action of capillary forces which pull the cells to approach and keep in close contact with the surface (Vučurović and Razmovski, 2012). Optical microscopic examination of yeast cells immobilized on hydrated SBP (Fig. 1b), confirmed that some of yeast cells were firmly adsorbed onto the specific parts

of surface of the support and also infiltrated into the small pores of the different parts of plant tissue structures, and then multiplied.

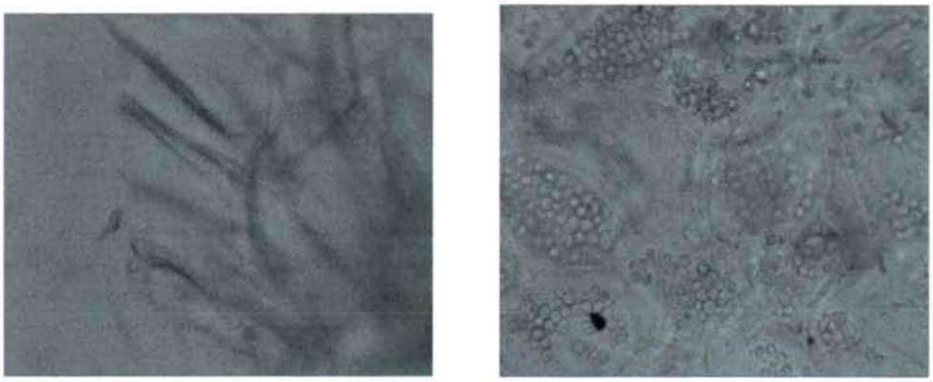

Figure 1. Optical microphotograph of hydrated SBP (a) and Saccharomyces cerevisiae cells (400×) immobilized onto the hydrated SBP (b).

By comparing obtained retention capacities for different yeast and support amounts (Fig. 2) it can be concluded that cells retention increased with the increase of initial yeast concentration from 3 g/l to 6 g/l, while it decreased with the increase of the suport amount from 10 g/l to 50 g/l the optimal yeast. On the basis of yeast immobilization results it can be concluded that the optimal cells retention capacity (R) of 0.117 g/g was achieved for initial yeast concentration of 6 g/l and support amount of 20 g/l. Due to the highest yeast cell retention capacity, immobilized biocatalyst under these optimal conditions was used for thin juice fermentation.

In the ethanol fermentation, the theoretical yield of ethanol and CO_2 is 0.511 g and 0.489 g per g of glucose metabolized, respectively. Hence, in the case of batch fermentation the CO_2 evolution rate could represent fermentation rate instead of ethanol production rate. From time-courses of CO_2 (Fig 3.) CO_2 production indicated normal behavior during the fermentation batch. According to the dynamic of CO_2 production (Fig. 3) very low fermentation time (48 h) was achieved. Fast fermentation times indicated that no period was needed for adaptation of biocatalyst in the fermentation environment. The immobilized yeast showed an important operational and stability without any decrease of its activity.

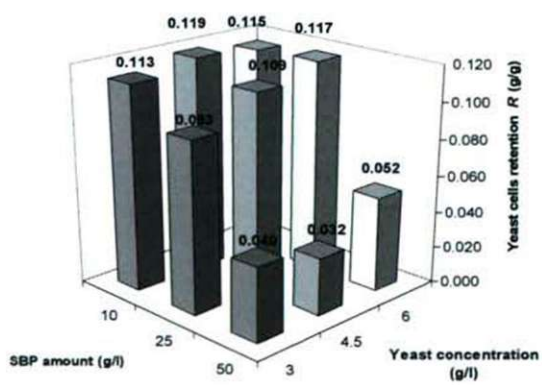

Figure 2. Rettention of S.cerevisiae cells onto hydrated SBP.

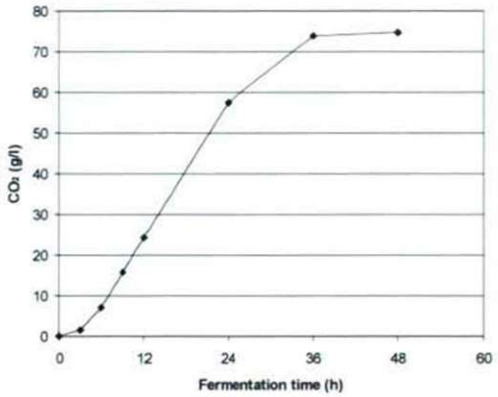

Figure 3. CO_2 production during the fermentation of sugar beet thin juice by S. cerevisiae immobilized on SBP

Table 1 summarizes the fermentation parameters such as sugar utilization, ethanol volumetric productivity, ethanol yield and percentage of theoretical yield obtained at the end of the fermentation batch of thin juice by *S. cerevisiae* immobilized onto hydrated SBP.

Table 1. Parameters of sugar beet thin juice fermentation by S. cerevisiae immobilized on hydrated SBP

Parameter	Value
Initial sugar, S_0 (g/l)	155.53
Utilized sugar, S_u (g/l)	151.95
Sugar conversion, S_u (%)	97.69
Ethanol concentration, P (g/l)	75.66
Ethanol productivity, Q_p (g/lh)	1.58
Ethanol yield, $Y_{p/s}$ (g/g)	0.499
Percetage of the theoretical yield, $E_{p/s}$ (%)	97.71

A maximum sugar conversion of 97.69%, indicated that immobilized cells onto SBP utilized almost all available sugar from thin juice sugesting that thin juice is very good raw material for ethanol production. Final ethanol concentration of 75.66 g/l and ethanol productivity of 1.58 g/lh were achieved at the end of thin juice fermentation batch. Ethanol yield per consumed sugar of 0.499 g/g was achieved, equal to 97.71% of its theoretical value, indicating that almost all utilized sugar was converted to ethanol during the fermentation process.

By comparing results obtained in the present work, with other biocatalysts prepared by yeast immobilization on natural, food grade materials that have been extensively studied, such as dignified cellulosic materials, gluten pellets, pieces of fruit etc. (Table 2) it can be concluded that the present biocatalyst was equally efficient for alcoholic fermentation.

Table 2. Fermentation parameters (average values) obtained in batch fermentations with Saccharomyces cerevisiae cells immobilized on various supports, at 30°C

Support material	Medium	Initial sugar (g/l)	Ferm. Time (h)	Residual sugar (g/l)	Ethanol P (g/l)	Ethanol productivity Q_p (g/ld)	Sugar conversion S_u (%)
Delignified cellulosic materials (Iconomou et al., 1996)	Molasses /sucrose	172	36	10.2	104	69.3	94
	Glucose	350	67	68	144	51.5	80.5
Gluten pellets (Bardi et al.,1996)	Glucose	119	15	12.5	39.5	63.2	89.5
	Grape must	206	17	18.9	83.7	118	90.1
Dried figs (Brkatorou et al., 2002)	Wort	129	18	0	47.4	64	100
	Glucose	120	45	1.4	45	24	98
Quince pieces (Kourkoutas et al., 2003)	Grape must	185	28	0.1	84	72	99.9
Apple pieces (Kourkoutas et al., 2001)	Grape must	206	80	30.8	85	26	85
	Glucose	125	9	4	51.4	128.3	96.8
	Molasses /sucrose	128	14	2	58.9	100.1	98.4
Orange peel (Plessas et al., 2007)	Raisin extract	124	12	2.3	55.3	110.4	98.1
Watermelon rind pieces (Reddy et al., 2008)	Grape must	202	64	tr	87.0	45.8	100
Sugar beet pulp (present study)	Thin juice /sucrose	150	48	3.6	75.66	1.58	97.7

4. CONCLUSION

The results demonstrated that efficient fermentation system was achieved by using *S. cerevisiae* immobilized onto the SBP as biocatalyst for alcoholic fermentation of sugar beet thin juice. Further investigation on specific food applications using this biocatalyst would be interesting.

AKNOWLEDGMENTS

Financial support of the Project TR-31002 from the Ministry of Science and Technological Development of the Republic of Serbia is highly acknowledged.

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